

# TEST REPORT

ACCORDING TO: FCC 47CFR part 15 subpart C § 15.247 (DTS) and subpart B

FOR:

**Augury Systems Ltd.**

**Vibration sensor**

**Model number: AC00009**

**FCC ID:2AJJIAC00009**

This report is in conformity with ISO/ IEC 17025. The "A2LA Accredited" symbol endorsement applies only to the tests and calibrations that are listed in the scope of Hermon Laboratories accreditation. The test results relate only to the items tested.  
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## 1 Applicant information

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**Telephone:** +972 50 742 5605  
**Fax:** NA  
**E-mail:** ashilo@augury.com  
**Contact name:** Mr. Avital Shilo

## 2 Equipment under test attributes

**Product name:** Vibration sensor  
**Product type:** Transceiver  
**Model(s):** AC00009  
**Serial number:** ZA103  
**Hardware version:** A+1  
**Software release:** 01.01.1056  
**Receipt date** 02-Apr-17

## 3 Manufacturer information

**Manufacturer name:** Augury Systems Ltd.  
**Address:** 33 Hanamal street, Haifa 3303132, Israel  
**Telephone:** +972 50 742 5605  
**Fax:** NA  
**E-Mail:** ashilo@augury.com  
**Contact name:** Mr. Avital Shilo

## 4 Test details

**Project ID:** 29418  
**Location:** Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel  
**Test started:** 02-Apr-17  
**Test completed:** 04-Apr-17  
**Test specification(s):** FCC 47CFR part 15 subpart C § 15.247 (DTS) and subpart B

## 5 Tests summary

| Test                                                | Status                                                            |
|-----------------------------------------------------|-------------------------------------------------------------------|
| <b>Transmitter characteristics</b>                  |                                                                   |
| FCC section 15.247(a)2, 6 dB bandwidth              | Pass                                                              |
| FCC section 15.247(b)3, Peak output power           | Pass                                                              |
| FCC section 15.247(i), RF exposure                  | Pass, the exhibit to the application of certification is provided |
| FCC section 15.247(d), Radiated spurious emissions  | Pass                                                              |
| FCC section 15.247(d), Emissions at band edges      | Pass                                                              |
| FCC section 15.247(e), Peak power density           | Pass                                                              |
| FCC section 15.203, Antenna requirement             | Pass                                                              |
| <b>Unintentional emissions</b>                      |                                                                   |
| Section 15.107, Conducted emission at AC power port | Not required                                                      |
| Section 15.109, Radiated emission                   | Pass                                                              |

Testing was completed against all relevant requirements of the test standard. The results obtained indicate that the product under test complies in full with the requirements tested.

The test results relate only to the items tested. Pass/ fail decision was based on nominal values.

This test report supersedes the previously issued test report identified by Doc ID:AUGRAD\_FCC.29418.

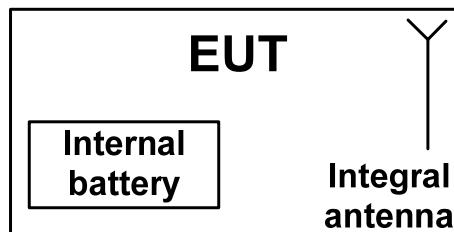
|                     | Name and Title                                                | Date          | Signature                                                                                                                                                                      |
|---------------------|---------------------------------------------------------------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Tested by:</b>   | Mr. K. Zushchuk, test engineer<br>Mrs. E. Pitt, test engineer | April 4, 2017 | <br> |
| <b>Reviewed by:</b> | Mrs. M. Cherniavsky, certification engineer                   | April 6, 2017 |                                                                                           |
| <b>Approved by:</b> | Mr. M. Nikishin, EMC and radio group leader                   | May 29, 2017  |                                                                                           |

## 6 EUT description

### 6.1 General information

The EUT is a battery powered, wireless, Tri-Axle vibration sensor. The endpoint is designed to be mounted and monitor rotating machinery. The EUT transmits continuous vibration and temperature data using Bluetooth wireless technology. Spectrum range is the 2.400–2.4835 GHz, the range is divided into 40 Channels with 2 MHz separation.

### 6.2 Test configuration



### 6.3 Changes made in EUT

No changes were implemented in the EUT during testing.

## 6.4 EUT test positions

Photograph 6.4.1 EUT in X-axis orthogonal position



Photograph 6.4.2 EUT in Y-axis orthogonal position



Photograph 6.4.3 EUT in Z-axis orthogonal position



## 6.5 Transmitter characteristics

|                                              |                                                                                                          |                                                           |         |                                |                                                                  |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|---------|--------------------------------|------------------------------------------------------------------|
| <b>Type of equipment</b>                     |                                                                                                          |                                                           |         |                                |                                                                  |
| X                                            | Stand-alone (Equipment with or without its own control provisions)                                       |                                                           |         |                                |                                                                  |
|                                              | Combined equipment (Equipment where the radio part is fully integrated within another type of equipment) |                                                           |         |                                |                                                                  |
|                                              | Plug-in card (Equipment intended for a variety of host systems)                                          |                                                           |         |                                |                                                                  |
| <b>Intended use</b>                          |                                                                                                          | <b>Condition of use</b>                                   |         |                                |                                                                  |
|                                              | fixed                                                                                                    | Always at a distance more than 2 m from all people        |         |                                |                                                                  |
| X                                            | mobile                                                                                                   | Always at a distance more than 20 cm from all people      |         |                                |                                                                  |
|                                              | portable                                                                                                 | May operate at a distance closer than 20 cm to human body |         |                                |                                                                  |
| <b>Assigned frequency range</b>              |                                                                                                          | 2400-2483.5 MHz                                           |         |                                |                                                                  |
| <b>Operating frequency range</b>             |                                                                                                          | 2402 – 2480 MHz                                           |         |                                |                                                                  |
| <b>Maximum rated output power</b>            |                                                                                                          | At transmitter 50 $\Omega$ RF output connector            |         | NA                             |                                                                  |
|                                              |                                                                                                          | Peak output power                                         |         | 7.9 dBm                        |                                                                  |
| <b>Is transmitter output power variable?</b> |                                                                                                          | X                                                         | No      |                                |                                                                  |
|                                              |                                                                                                          |                                                           | Yes     | continuous variable            |                                                                  |
|                                              |                                                                                                          | stepped variable with stepsize                            |         | dB                             |                                                                  |
|                                              |                                                                                                          | minimum RF power                                          |         | dBm                            |                                                                  |
|                                              |                                                                                                          | maximum RF power                                          |         | dBm                            |                                                                  |
| <b>Antenna connection</b>                    |                                                                                                          |                                                           |         |                                |                                                                  |
| unique coupling                              |                                                                                                          | standard connector                                        |         | X                              | integral                                                         |
|                                              |                                                                                                          |                                                           |         | with temporary RF connector    |                                                                  |
|                                              |                                                                                                          |                                                           |         | without temporary RF connector |                                                                  |
| <b>Antenna/s technical characteristics</b>   |                                                                                                          |                                                           |         |                                |                                                                  |
| <b>Type</b>                                  |                                                                                                          | <b>Manufacturer</b>                                       |         | <b>Model number</b>            |                                                                  |
| Internal, printed                            |                                                                                                          | Augury Systems                                            |         | Monopole                       |                                                                  |
|                                              |                                                                                                          |                                                           |         | Gain                           |                                                                  |
|                                              |                                                                                                          |                                                           |         | 1 dBi                          |                                                                  |
| <b>Type of modulation</b>                    |                                                                                                          | GFSK (BLE)                                                |         |                                |                                                                  |
| <b>Modulating test signal (baseband)</b>     |                                                                                                          | PRBS                                                      |         |                                |                                                                  |
| <b>Transmitter aggregate data rate</b>       |                                                                                                          | 1 MBps                                                    |         |                                |                                                                  |
| <b>Transmitter power source</b>              |                                                                                                          |                                                           |         |                                |                                                                  |
| X                                            | Battery                                                                                                  | <b>Nominal rated voltage</b>                              | 3.6 VDC | <b>Battery type</b>            | Primary lithium-thionyl chloride (Li-SOCl <sub>2</sub> ), C size |
|                                              | DC                                                                                                       | <b>Nominal rated voltage</b>                              | VDC     |                                |                                                                  |
|                                              | AC mains                                                                                                 | <b>Nominal rated voltage</b>                              | VAC     | <b>Frequency</b>               |                                                                  |

|                                                                      |                                |                               |                       |
|----------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> <b>Section 15.247(a)2, 6 dB bandwidth</b> |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.8.1                    |                                |                               |                       |
| <b>Test mode:</b> Compliance                                         |                                | <b>Verdict:</b> <b>PASS</b>   |                       |
| <b>Date(s):</b> 03-Apr-17                                            |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                            | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                      |                                |                               |                       |

## 7 Transmitter tests according to 47CFR part 15 subpart C requirements

### 7.1 Minimum 6 dB bandwidth

#### 7.1.1 General

This test was performed to measure 6 dB bandwidth of the EUT carrier frequency. Specification test limits are given in Table 7.1.1.

Table 7.1.1 The 6 dB bandwidth limits

| Assigned frequency, MHz | Modulation envelope reference points*, dBc | Minimum bandwidth, kHz |
|-------------------------|--------------------------------------------|------------------------|
| 2400.0 – 2483.5         | 6.0                                        | 500.0                  |

\* - Modulation envelope reference points provided in terms of attenuation below the peak of modulated carrier.

#### 7.1.2 Test procedure

7.1.2.1 The EUT was set up as shown in Figure 7.1.1, energized and its proper operation was checked.

7.1.2.2 The EUT was set to transmit modulated carrier.

7.1.2.3 The transmitter minimum 6 dB bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.1.2 and associated plot.

Figure 7.1.1 The 6 dB bandwidth test setup





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|                                                                      |                                |                               |                       |
|----------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> <b>Section 15.247(a)2, 6 dB bandwidth</b> |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.8.1                    |                                |                               |                       |
| <b>Test mode:</b> Compliance                                         |                                | <b>Verdict:</b> <b>PASS</b>   |                       |
| <b>Date(s):</b> 03-Apr-17                                            |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                            | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                      |                                |                               |                       |

Table 7.1.2 The 6 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 2400-2483.5 MHz  
 DETECTOR USED: Peak  
 SWEEP TIME: Auto  
 RESOLUTION BANDWIDTH: 100 kHz  
 VIDEO BANDWIDTH: 300 kHz  
 MODULATION ENVELOPE REFERENCE POINTS: 6.0 dBc  
 MODULATION: GFSK  
 BIT RATE: 1 Mbps

| Carrier frequency, MHz | 6 dB bandwidth, kHz | Limit, kHz | Margin, kHz | Verdict |
|------------------------|---------------------|------------|-------------|---------|
| 2402                   | 706.71              | 500        | 206.71      | Pass    |
| 2440                   | 704.48              | 500        | 204.48      | Pass    |
| 2480                   | 710.05              | 500        | 210.05      | Pass    |

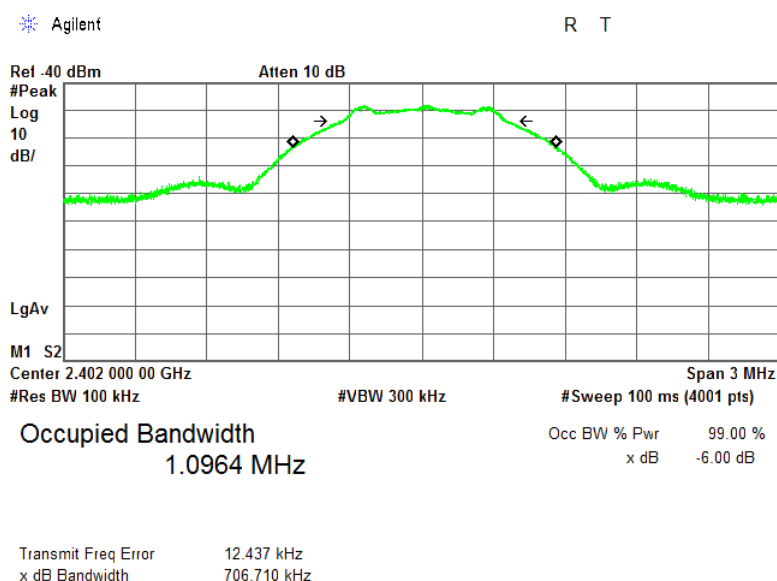
**Reference numbers of test equipment used**

|         |  |  |  |  |  |  |  |  |
|---------|--|--|--|--|--|--|--|--|
| HL 3818 |  |  |  |  |  |  |  |  |
|---------|--|--|--|--|--|--|--|--|

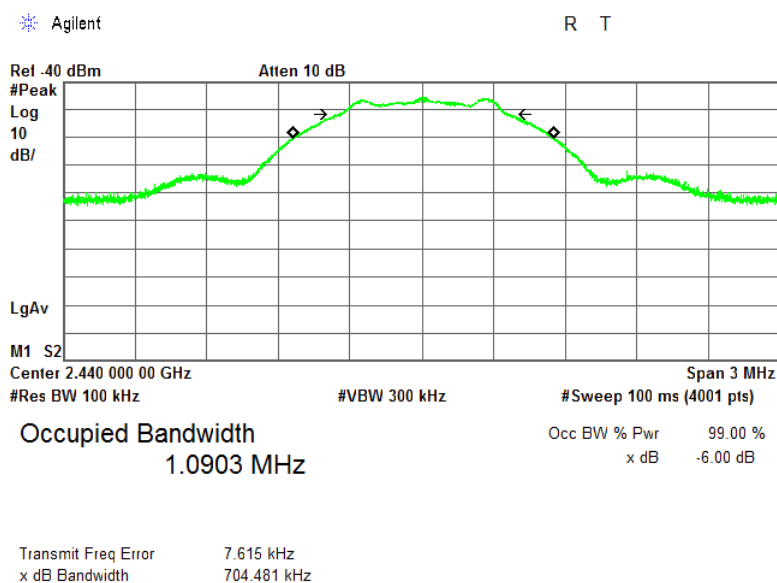
Full description is given in Appendix A.

|                                                                      |                                |                               |                       |
|----------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> <b>Section 15.247(a)2, 6 dB bandwidth</b> |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.8.1                    |                                |                               |                       |
| <b>Test mode:</b> Compliance                                         |                                | <b>Verdict:</b> <b>PASS</b>   |                       |
| <b>Date(s):</b> 03-Apr-17                                            |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                            | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                      |                                |                               |                       |

Plot 7.1.1 The 6 dB bandwidth test result at low frequency

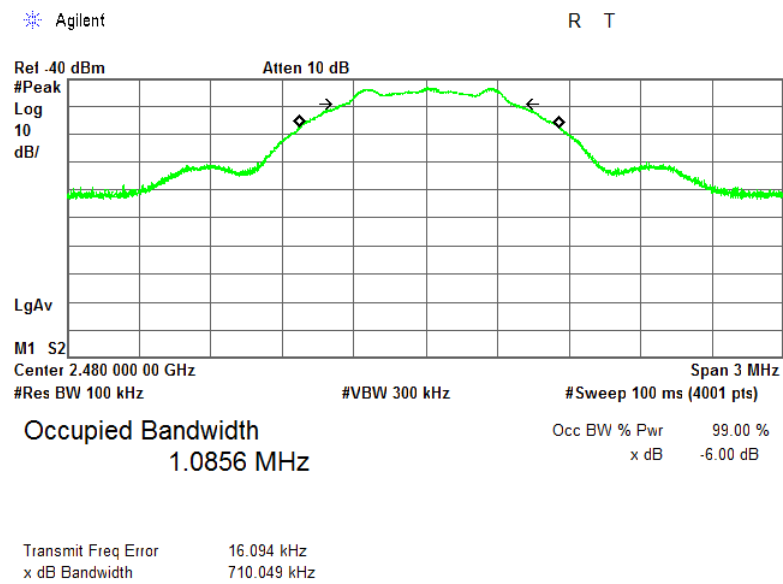


Plot 7.1.2 The 6 dB bandwidth test result at mid frequency



|                     |                         |                                    |                |
|---------------------|-------------------------|------------------------------------|----------------|
| Test specification: |                         | Section 15.247(a)2, 6 dB bandwidth |                |
| Test procedure:     |                         | ANSI C63.10 section 11.8.1         |                |
| Test mode:          |                         | Verdict: PASS                      |                |
| Date(s):            |                         |                                    |                |
| 03-Apr-17           |                         |                                    |                |
| Temperature: 23 °C  | Relative Humidity: 45 % | Air Pressure: 1010 hPa             | Power: Battery |
| Remarks:            |                         |                                    |                |

Plot 7.1.3 The 6 dB bandwidth test result at high frequency



|                                                                            |                                |                               |                       |
|----------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> <b>Section 15.247(b)3, Maximum output power</b> |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.9.1.1                        |                                |                               |                       |
| <b>Test mode:</b> Compliance                                               |                                | <b>Verdict:</b> <b>PASS</b>   |                       |
| <b>Date(s):</b> 04-Apr-17                                                  |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                  | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                            |                                |                               |                       |

## 7.2 Peak output power

### 7.2.1 General

This test was performed to measure the maximum peak output power radiated by transmitter. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Peak output power limits

| Assigned frequency range, MHz | Maximum antenna gain, dBi | Peak output power* |      | Equivalent field strength limit @ 3m, dB(μV/m)** |
|-------------------------------|---------------------------|--------------------|------|--------------------------------------------------|
|                               |                           | W                  | dBm  |                                                  |
| 902.0 – 928.0                 | 6.0                       | 1.0                | 30.0 | 131.2                                            |
| 2400.0 – 2483.5               |                           |                    |      |                                                  |
| 5725.0 – 5850.0               |                           |                    |      |                                                  |

\*- The limit is provided in terms of conducted RF power at the antenna connector. If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power limit shall be reduced below the stated value as follows:

- by 1 dB for every 3 dB that the directional gain of antenna exceeds 6 dBi for fixed point-to-point transmitters operate in 2400-2483.5 MHz band;
- without any corresponding reduction for fixed point-to-point transmitters operate in 5725-5850 MHz band;
- by the amount in dB that the directional gain of antenna exceeds 6 dBi for the rest of transmitters.

\*\* - Equivalent field strength limit was calculated from the peak output power as follows:  $E = \sqrt{30 \times P \times G} / r$ , where P is peak output power in Watts, r is antenna to EUT distance in meters and G is transmitter antenna gain in dBi.

### 7.2.2 Test procedure

7.2.2.1 The EUT was set up as shown in Figure 7.2.1, energized and its proper operation was checked.

7.2.2.2 The EUT was adjusted to produce maximum available to end user RF output power.

7.2.2.3 The resolution bandwidth of spectrum analyzer was set wider than 6 dB bandwidth of the EUT and the field strength of the EUT carrier frequency was measured with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna height was swept in both vertical and horizontal polarizations.

7.2.2.4 The maximum field strength of the EUT carrier frequency was measured as provided in Table 7.2.2 and associated plots.

7.2.2.5 The maximum peak output power was calculated from the field strength of carrier as follows:

$$P = (E \times d)^2 / (30 \times G),$$

where P is the peak output power in W, E is the field strength in V/m, d is the test distance and G is the transmitter numeric antenna gain over an isotropic radiator.

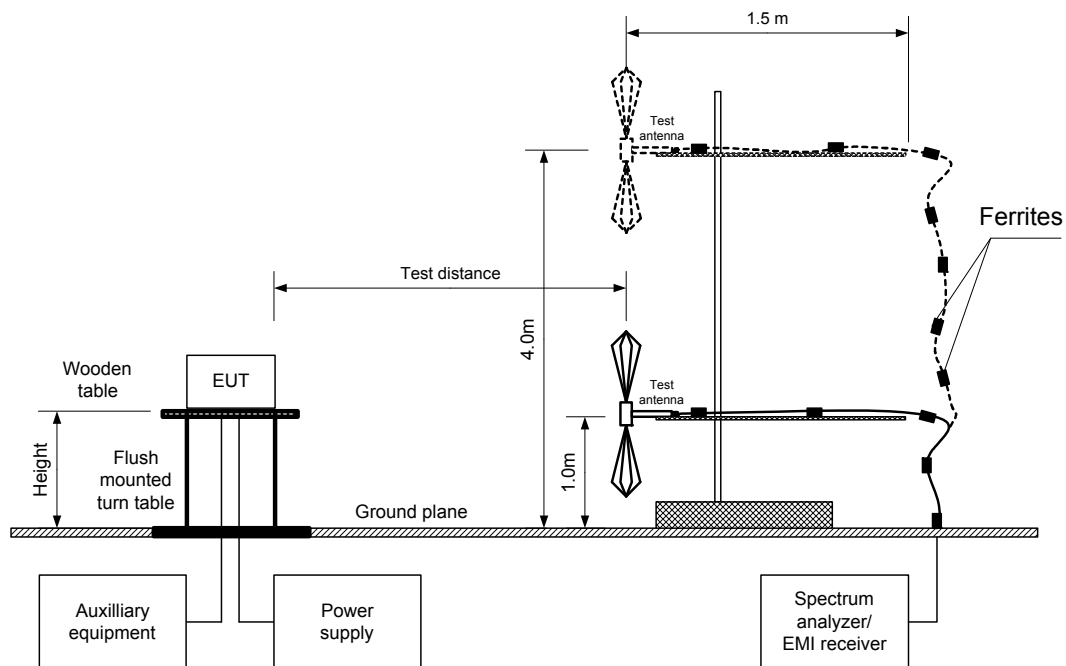
The above equation was converted in logarithmic units for 3 m test distance:

$$\text{Peak output power in dBm} = \text{Field strength in dB}(\mu\text{V/m}) - \text{Transmitter antenna gain in dBi} - 95.2 \text{ dB}$$

7.2.2.6 The worst test results (the lowest margins) were recorded in Table 7.2.2.

|                                                                     |                                |                               |                       |
|---------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(b)3, Maximum output power |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.9.1.1                 |                                |                               |                       |
| <b>Test mode:</b> Compliance                                        |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 04-Apr-17                                           |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                           | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                     |                                |                               |                       |

Figure 7.2.1 Setup for carrier field strength measurements





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|                                                                     |                                |                               |                       |
|---------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(b)3, Maximum output power |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.9.1.1                 |                                |                               |                       |
| <b>Test mode:</b> Compliance                                        |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 04-Apr-17                                           |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                           | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                     |                                |                               |                       |

Table 7.2.2 Peak output power test results

ASSIGNED FREQUENCY: 2400-2483.5 MHz  
 TEST DISTANCE: 3 m  
 TEST SITE: OATS  
 EUT HEIGHT: 1.5 m  
 DETECTOR USED: Peak  
 TEST ANTENNA TYPE: Double ridged guide (above 1000 MHz)  
 MODULATION: GFSK  
 BIT RATE: 1 Mbps  
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum  
 DETECTOR USED: Peak

| Frequency, MHz | Field strength, dB(μV/m) | Antenna polarization | Antenna height, m | Azimuth, degrees* | EUT antenna gain, dBi | Peak output power, dBm** | Limit, dBm | Margin, dB*** | Verdict |
|----------------|--------------------------|----------------------|-------------------|-------------------|-----------------------|--------------------------|------------|---------------|---------|
| 2402.00        | 103.90                   | Horizontal           | 1.6               | 208               | 1                     | 7.70                     | 30         | -22.3         | Pass    |
| 2440.00        | 102.80                   | Horizontal           | 1.5               | 215               | 1                     | 6.60                     | 30         | -23.4         | Pass    |
| 2480.00        | 104.10                   | Horizontal           | 1.5               | 212               | 1                     | 7.90                     | 30         | -22.1         | Pass    |

\*- EUT front panel refer to 0 degrees position of turntable.

\*\* - Peak output power was calculated from the field strength of carrier as follows:  $P = (E \times d)^2 / (30 \times G)$ , where P is the peak output power in W, E is the field strength in V/m, d is the test distance in meters and G is the transmitter numeric antenna gain over an isotropic radiator. The above equation was converted in logarithmic units for 3 m test distance: *Peak output power in dBm = Field strength in dB(μV/m) - Transmitter antenna gain in dBi - 95.2 dB*

\*\*\* - Margin = Peak output power – specification limit.

#### Reference numbers of test equipment used

|         |         |         |  |  |  |  |  |
|---------|---------|---------|--|--|--|--|--|
| HL 2909 | HL 4114 | HL 5103 |  |  |  |  |  |
|---------|---------|---------|--|--|--|--|--|

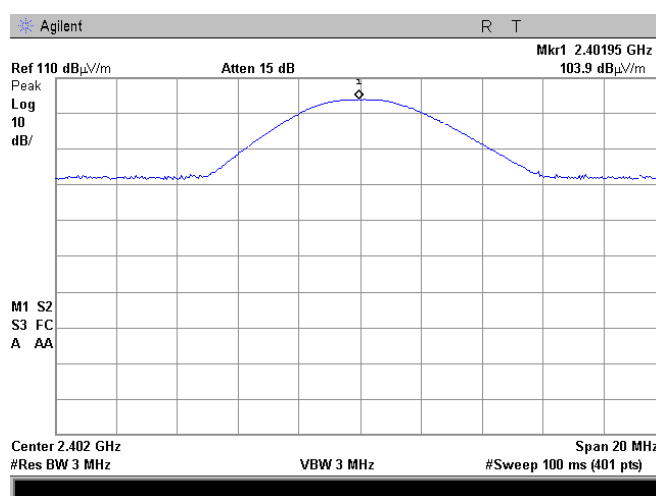
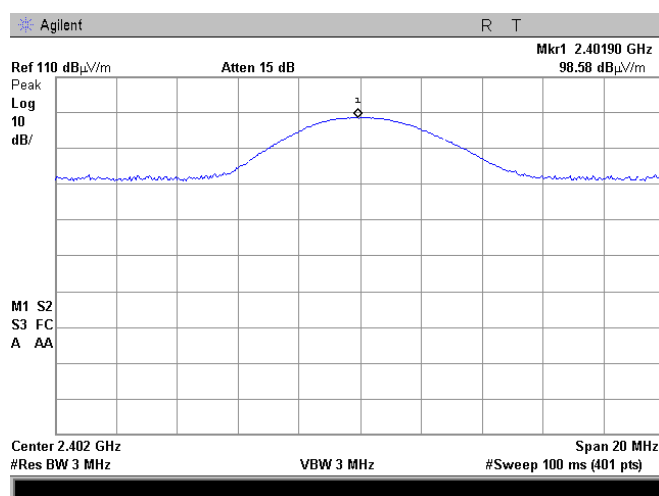
Full description is given in Appendix A.

|                                                                     |                                |                               |                       |
|---------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(b)3, Maximum output power |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.9.1.1                 |                                |                               |                       |
| <b>Test mode:</b> Compliance                                        |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 04-Apr-17                                           |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                           | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                     |                                |                               |                       |

Plot 7.2.1 Field strength of carrier at low frequency

TEST SITE:  
TEST DISTANCE:  
EUT POSITION:  
ANTENNA POLARIZATION: Vertical

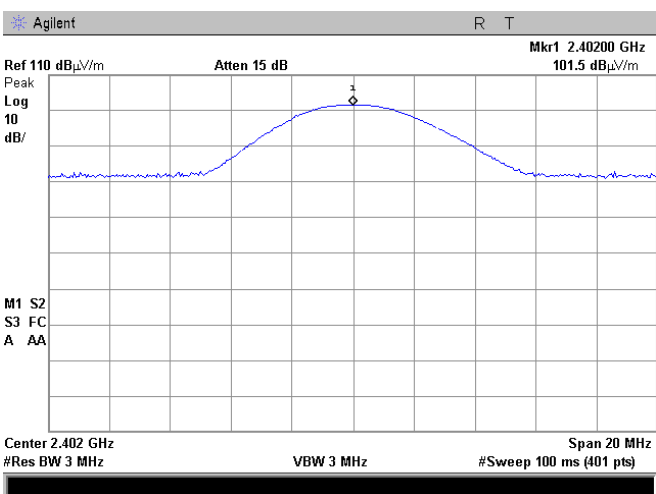
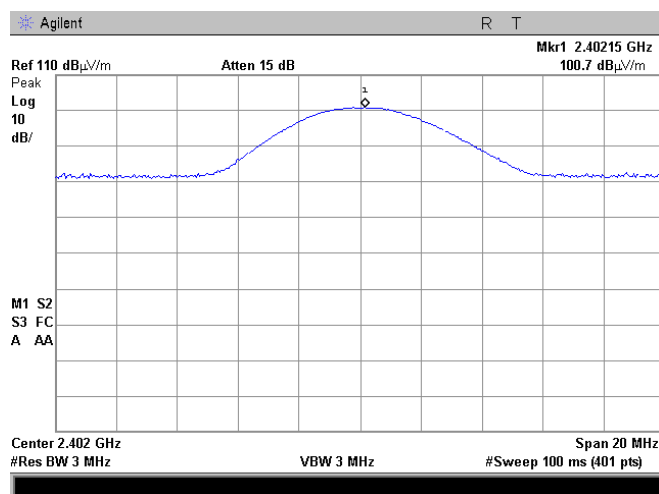
OATS  
3 m  
X-axis  
ANTENNA POLARIZATION: Horizontal



Plot 7.2.2 Field strength of carrier at low frequency

TEST SITE:  
TEST DISTANCE:  
EUT POSITION:  
ANTENNA POLARIZATION: Vertical

OATS  
3 m  
Y-axis  
ANTENNA POLARIZATION: Horizontal

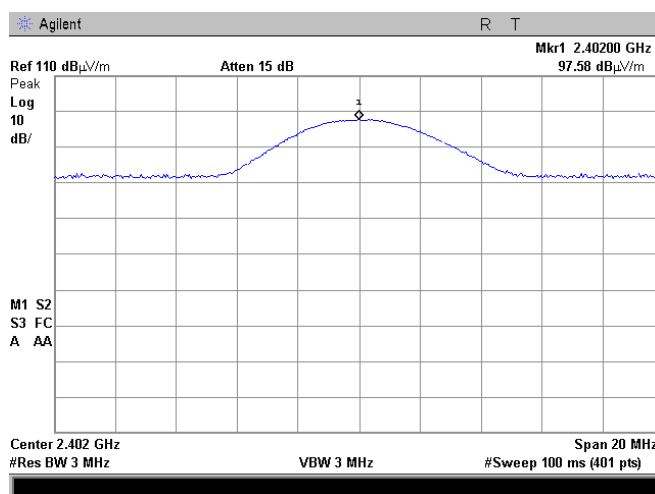
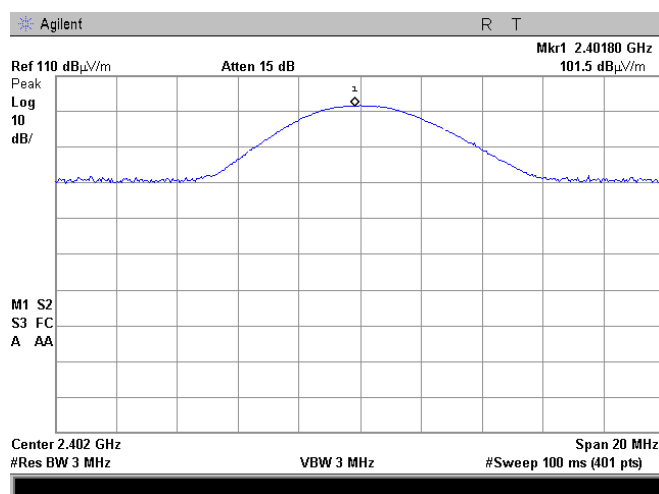


|                                                                     |                                |                               |                       |
|---------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(b)3, Maximum output power |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.9.1.1                 |                                |                               |                       |
| <b>Test mode:</b> Compliance                                        |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 04-Apr-17                                           |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                           | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                     |                                |                               |                       |

Plot 7.2.3 Field strength of carrier at low frequency

TEST SITE:  
TEST DISTANCE:  
EUT POSITION:  
ANTENNA POLARIZATION: Vertical

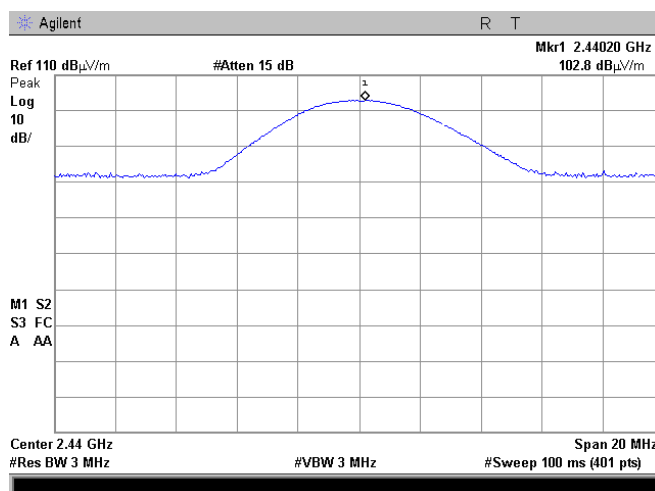
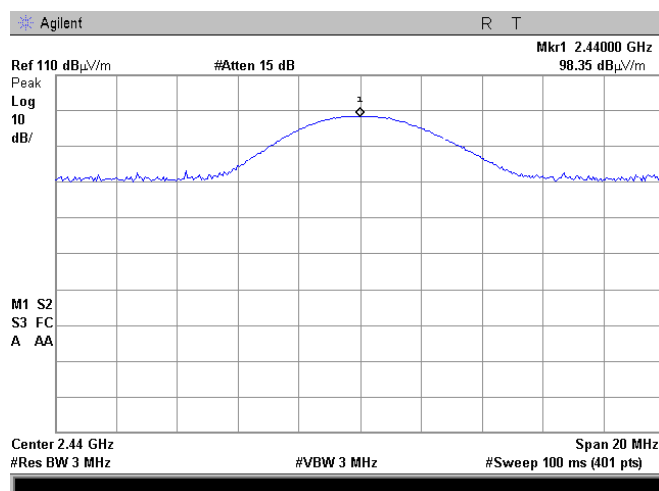
OATS  
3 m  
Z-axis  
ANTENNA POLARIZATION: Horizontal



Plot 7.2.4 Field strength of carrier at mid frequency

TEST SITE:  
TEST DISTANCE:  
EUT POSITION:  
ANTENNA POLARIZATION: Vertical

OATS  
3 m  
X-axis  
ANTENNA POLARIZATION: Horizontal





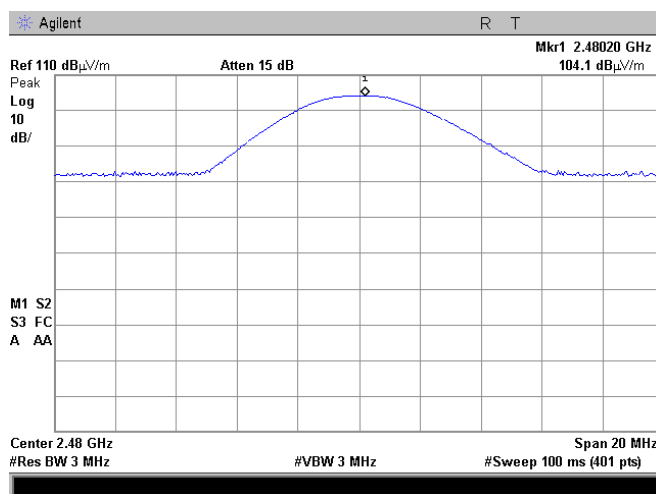
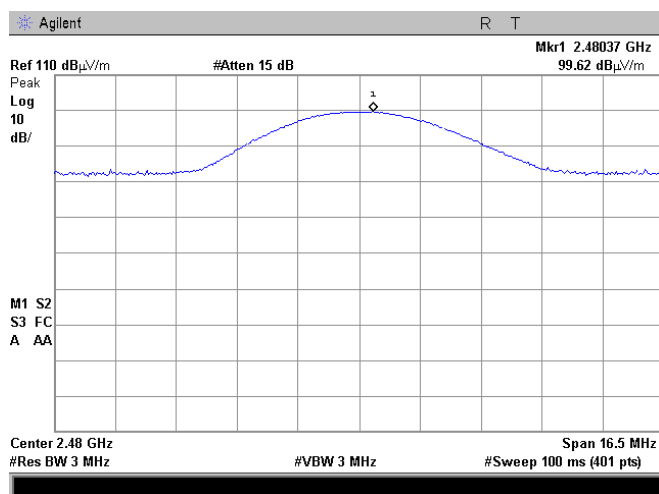
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|                                                              |                         |                        |                |
|--------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(b)3, Maximum output power |                         |                        |                |
| Test procedure: ANSI C63.10 section 11.9.1.1                 |                         |                        |                |
| Test mode: Compliance                                        |                         | Verdict: PASS          |                |
| Date(s): 04-Apr-17                                           |                         |                        |                |
| Temperature: 23 °C                                           | Relative Humidity: 45 % | Air Pressure: 1010 hPa | Power: Battery |
| Remarks:                                                     |                         |                        |                |

Plot 7.2.5 Field strength of carrier at high frequency

TEST SITE:  
TEST DISTANCE:  
EUT POSITION:  
ANTENNA POLARIZATION: Vertical

OATS  
3 m  
X-axis  
ANTENNA POLARIZATION: Horizontal





|                                                                                  |                                |                               |                       |
|----------------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> <b>Section 15.247(d), Radiated spurious emissions</b> |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                               |                                |                               |                       |
| <b>Test mode:</b> Compliance                                                     |                                | <b>Verdict:</b> <b>PASS</b>   |                       |
| <b>Date(s):</b> 03-Apr-17 - 04-Apr-17                                            |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                        | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                                  |                                |                               |                       |

## 7.3 Field strength of spurious emissions

### 7.3.1 General

This test was performed to measure field strength of spurious emissions from the EUT. Specification test limits are given in Table 7.3.1.

**Table 7.3.1 Radiated spurious emissions limits**

| Frequency, MHz                   | Field strength at 3 m within restricted bands, dB(μV/m)*** |                 |                 | Attenuation of field strength of spurious versus carrier outside restricted bands, dBc*** |
|----------------------------------|------------------------------------------------------------|-----------------|-----------------|-------------------------------------------------------------------------------------------|
|                                  | Peak                                                       | Quasi Peak      | Average         |                                                                                           |
| 0.009 – 0.090                    | 148.5 – 128.5                                              | NA              | 128.5 – 108.5** | 20.0                                                                                      |
| 0.090 – 0.110                    | NA                                                         | 108.5 – 106.8** | NA              |                                                                                           |
| 0.110 – 0.490                    | 126.8 – 113.8                                              | NA              | 106.8 – 93.8**  |                                                                                           |
| 0.490 – 1.705                    | NA                                                         | 73.8 – 63.0**   | NA              |                                                                                           |
| 1.705 – 30.0*                    |                                                            | 69.5            |                 |                                                                                           |
| 30 – 88                          |                                                            | 40.0            |                 |                                                                                           |
| 88 – 216                         |                                                            | 43.5            |                 |                                                                                           |
| 216 – 960                        |                                                            | 46.0            |                 |                                                                                           |
| 960 - 1000                       |                                                            | 54.0            |                 |                                                                                           |
| 1000 – 10 <sup>th</sup> harmonic | 74.0                                                       | NA              | 54.0            |                                                                                           |

\*- The limit for 3 m test distance was calculated using the inverse square distance extrapolation factor as follows:

$$\text{Lim}_{S_2} = \text{Lim}_{S_1} + 40 \log (S_1/S_2),$$

where  $S_1$  and  $S_2$  – standard defined and test distance respectively in meters.

\*\* - The limit decreases linearly with the logarithm of frequency.

\*\*\* - The field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency.

### 7.3.2 Test procedure for spurious emission field strength measurements in 9 kHz to 30 MHz band

**7.3.2.1** The EUT was set up as shown in Figure 7.3.1, energized and the performance check was conducted.

**7.3.2.2** The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated around its vertical axis.

**7.3.2.3** The worst test results (the lowest margins) were recorded and shown in the associated plots.

### 7.3.3 Test procedure for spurious emission field strength measurements above 30 MHz

**7.3.3.1** The EUT was set up as shown in Figure 7.3.2, Figure 7.3.3, energized and the performance check was conducted.

**7.3.3.2** The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

**7.3.3.3** The worst test results (the lowest margins) were recorded and shown in the associated plots.

|                                                                                  |                                |                               |                       |
|----------------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> <b>Section 15.247(d), Radiated spurious emissions</b> |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                               |                                |                               |                       |
| <b>Test mode:</b> Compliance                                                     |                                | <b>Verdict:</b> <b>PASS</b>   |                       |
| <b>Date(s):</b> 03-Apr-17 - 04-Apr-17                                            |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                        | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                                  |                                |                               |                       |

Figure 7.3.1 Setup for spurious emission field strength measurements below 30 MHz

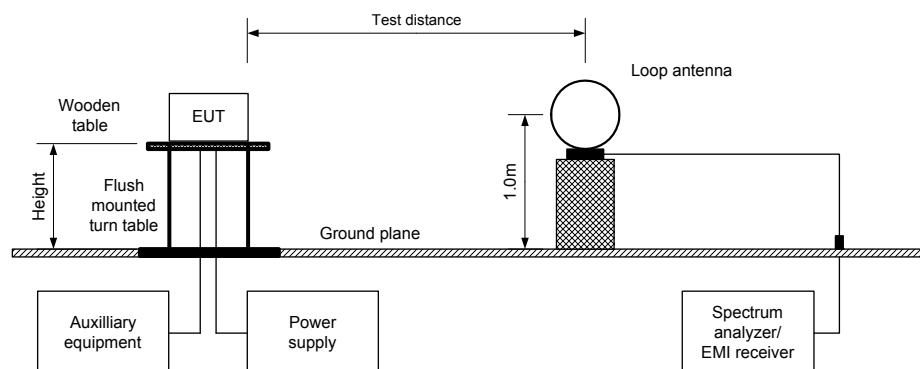
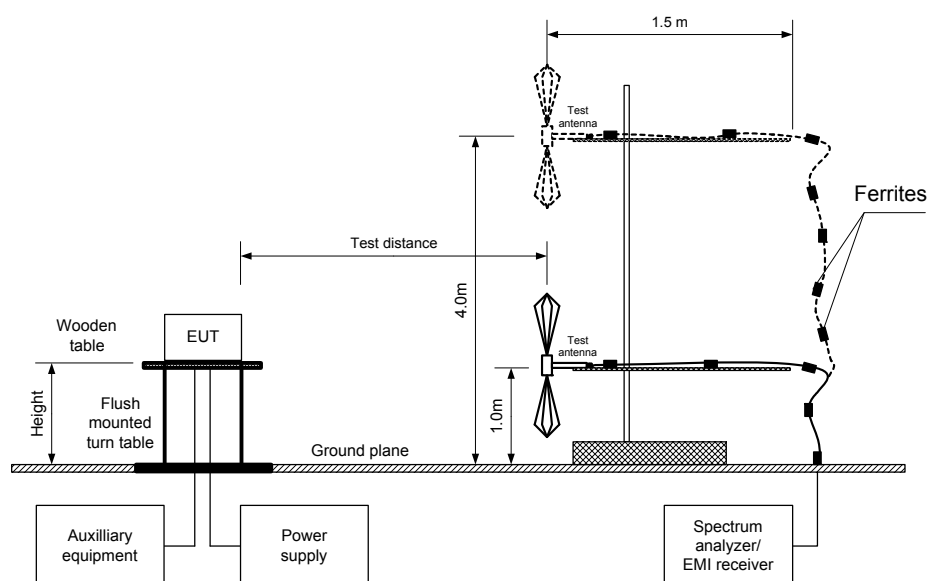
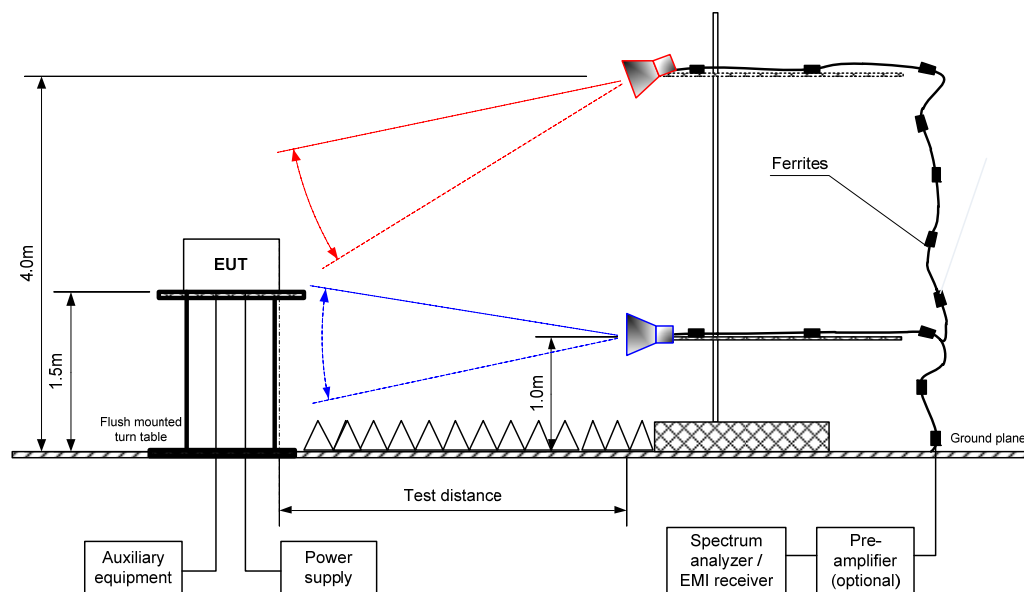


Figure 7.3.2 Setup for spurious emission field strength measurements from 30 to 1000 MHz



|                                                                           |                                |                               |                       |
|---------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(d), Radiated spurious emissions |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                        |                                |                               |                       |
| <b>Test mode:</b> Compliance                                              |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 03-Apr-17 - 04-Apr-17                                     |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                 | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                           |                                |                               |                       |

Figure 7.3.3 Setup for spurious emission field strength measurements above 1000 MHz





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|                                                                                  |                                |                               |                       |
|----------------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> <b>Section 15.247(d), Radiated spurious emissions</b> |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                               |                                |                               |                       |
| <b>Test mode:</b> Compliance                                                     |                                | <b>Verdict:</b> <b>PASS</b>   |                       |
| <b>Date(s):</b> 03-Apr-17 - 04-Apr-17                                            |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                        | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                                  |                                |                               |                       |

Table 7.3.2 Field strength of emissions outside restricted bands

ASSIGNED FREQUENCY: 2400-2483.5 MHz  
 INVESTIGATED FREQUENCY RANGE: 0.009 - 25000 MHz  
 TEST DISTANCE: 3 m  
 MODULATION: GFSK  
 BIT RATE: 1 Mbps  
 DUTY CYCLE: 100 %  
 DETECTOR USED: Peak  
 RESOLUTION BANDWIDTH: 100 kHz  
 VIDEO BANDWIDTH: 300 kHz  
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)  
 Biconical (30 MHz – 200 MHz)  
 Log periodic (200 MHz – 1000 MHz)  
 Biconilog (30 MHz – 1000 MHz)  
 Double ridged guide (above 1000 MHz)  
 FREQUENCY HOPPING: Disabled

| Frequency, MHz                | Field strength of spurious, dB(μV/m) | Antenna polarization | Antenna height, m | Azimuth, degrees* | Field strength of carrier, dB(μV/m) | Attenuation below carrier, dBc | Limit, dBc | Margin, dB** | Verdict |
|-------------------------------|--------------------------------------|----------------------|-------------------|-------------------|-------------------------------------|--------------------------------|------------|--------------|---------|
| <b>Low carrier frequency</b>  |                                      |                      |                   |                   |                                     |                                |            |              |         |
| 7206                          | 38.76                                | Horizontal           | 1.5               | 200               | 102.6                               | 63.84                          | 20.0       | 43.84        | Pass    |
| <b>Mid carrier frequency</b>  |                                      |                      |                   |                   |                                     |                                |            |              |         |
| 2504                          | 46.28                                | Horizontal           | 1.3               | 90                | 102.7                               | 56.42                          | 20.0       | 36.42        | Pass    |
| <b>High carrier frequency</b> |                                      |                      |                   |                   |                                     |                                |            |              |         |
| 2544                          | 44.99                                | Horizontal           | 1.3               | 90                | 102.5                               | 57.51                          | 20.0       | 37.51        | Pass    |

\*- EUT front panel refers to 0 degrees position of turntable.

\*\*- Margin = Attenuation below carrier – specification limit.



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|                                                                                  |                                |                               |                       |
|----------------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> <b>Section 15.247(d), Radiated spurious emissions</b> |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                               |                                |                               |                       |
| <b>Test mode:</b> Compliance                                                     |                                | <b>Verdict:</b> <b>PASS</b>   |                       |
| <b>Date(s):</b> 03-Apr-17 - 04-Apr-17                                            |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                        | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                                  |                                |                               |                       |

**Table 7.3.3 Field strength of spurious emissions above 1 GHz within restricted bands**

ASSIGNED FREQUENCY: 2400-2483.5 MHz  
 INVESTIGATED FREQUENCY RANGE: 1000 - 25000 MHz  
 TEST DISTANCE: 3 m  
 MODULATION: GFSK  
 BIT RATE: 1 Mbps  
 DUTY CYCLE: 100 %  
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum  
 DETECTOR USED: Peak  
 RESOLUTION BANDWIDTH: 1000 kHz  
 TEST ANTENNA TYPE: Double ridged guide  
 FREQUENCY HOPPING: Disabled

| Frequency, MHz                  |          |           | Antenna            |                 | Azimuth, degrees* | Peak field strength(VBW=3 MHz) |                    |                      | Average field strength(VBW=10 Hz) |               |      |  | Verdict |
|---------------------------------|----------|-----------|--------------------|-----------------|-------------------|--------------------------------|--------------------|----------------------|-----------------------------------|---------------|------|--|---------|
| Polarization                    |          | Height, m | Measured, dB(μV/m) | Limit, dB(μV/m) |                   | Margin, dB**                   | Measured, dB(μV/m) | Calculated, dB(μV/m) | Limit, dB(μV/m)                   | Margin, dB*** |      |  |         |
| Low carrier frequency 2402 MHz  |          |           |                    |                 |                   |                                |                    |                      |                                   |               |      |  |         |
| 4804                            | Vertical | 1.5       | 149                | 43.98           | 74                | -30.02                         | 39.29              | 19.29                | 54                                | -34.71        | Pass |  |         |
| Mid carrier frequency 2440 MHz  |          |           |                    |                 |                   |                                |                    |                      |                                   |               |      |  |         |
| 4880                            | Vertical | 1.5       | 0                  | 44.87           | 74                | -29.13                         | 40.71              | 20.71                | 54                                | -33.29        | Pass |  |         |
| 7320                            | Vertical | 1.5       | 200                | 44.53           | 74                | -29.47                         | 36.40              | 16.40                | 54                                | -37.60        |      |  |         |
| High carrier frequency 2480 MHz |          |           |                    |                 |                   |                                |                    |                      |                                   |               |      |  |         |
| 4960                            | Vertical | 1.5       | 0                  | 42.53           | 74                | -31.47                         | 36.83              | 16.83                | 54                                | -37.17        | Pass |  |         |
| 7440                            | Vertical | 1.5       | 250                | 46.33           | 74                | -27.67                         | 39.25              | 19.25                | 54                                | -34.75        |      |  |         |

\*- EUT front panel refers to 0 degrees position of turntable.

\*\*- Margin = Measured field strength - specification limit.

\*\*\*- Margin = Calculated field strength - specification limit,  
where Calculated field strength = Measured field strength + average factor.

**Table 7.3.4 Average factor calculation**

| Transmission pulse |            | Transmission burst |            | Transmission train duration, ms | Average factor, dB |
|--------------------|------------|--------------------|------------|---------------------------------|--------------------|
| Duration, ms       | Period, ms | Duration, ms       | Period, ms |                                 |                    |
| 10                 | 277        | NA                 | NA         | NA                              | -20                |

\*- Average factor was calculated as follows

for pulse train shorter than 100 ms:

$$\text{Average factor} = 20 \times \log_{10} \left( \frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{Burst duration}}{\text{Train duration}} \times \text{Number of bursts within pulse train} \right)$$

for pulse train longer than 100 ms:

$$\text{Average factor} = 20 \times \log_{10} \left( \frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{Burst duration}}{100 \text{ ms}} \times \text{Number of bursts within 100 ms} \right)$$



|                                                                           |                                |                               |                       |
|---------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(d), Radiated spurious emissions |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                        |                                |                               |                       |
| <b>Test mode:</b> Compliance                                              |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 03-Apr-17 - 04-Apr-17                                     |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                 | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                           |                                |                               |                       |

Table 7.3.5 Field strength of spurious emissions below 1 GHz within restricted bands

|                                    |                                   |
|------------------------------------|-----------------------------------|
| ASSIGNED FREQUENCY:                | 2400-2483.5 MHz                   |
| INVESTIGATED FREQUENCY RANGE:      | 0.009 – 1000 MHz                  |
| TEST DISTANCE:                     | 3 m                               |
| MODULATION:                        | GFSK                              |
| BIT RATE:                          | 1 Mbps                            |
| DUTY CYCLE:                        | 100 %                             |
| TRANSMITTER OUTPUT POWER SETTINGS: | Maximum                           |
| RESOLUTION BANDWIDTH:              | 0.2 kHz (9 kHz – 150 kHz)         |
|                                    | 9.0 kHz (150 kHz – 30 MHz)        |
|                                    | 120 kHz (30 MHz – 1000 MHz)       |
| VIDEO BANDWIDTH:                   | > Resolution bandwidth            |
| TEST ANTENNA TYPE:                 | Active loop (9 kHz – 30 MHz)      |
|                                    | Biconical (30 MHz – 200 MHz)      |
|                                    | Log periodic (200 MHz – 1000 MHz) |
|                                    | Biconilog (30 MHz – 1000 MHz)     |
| FREQUENCY HOPPING:                 | Disabled                          |

| Frequency, MHz          |                             | Quasi-peak      |             |  | Antenna polarization | Antenna height, m | Turn-table position**, degrees | Verdict |
|-------------------------|-----------------------------|-----------------|-------------|--|----------------------|-------------------|--------------------------------|---------|
| Peak emission, dB(μV/m) | Measured emission, dB(μV/m) | Limit, dB(μV/m) | Margin, dB* |  |                      |                   |                                |         |
| No signals were found   |                             |                 |             |  |                      |                   |                                | Pass    |

## Reference numbers of test equipment used

|         |         |         |         |         |         |         |         |
|---------|---------|---------|---------|---------|---------|---------|---------|
| HL 0446 | HL 2432 | HL 2780 | HL 2697 | HL 4338 | HL 4933 | HL 4956 | HL 5107 |
| HL 5110 | HL 5112 |         |         |         |         |         |         |

Full description is given in Appendix A.



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|                       |                         |                                                |                |
|-----------------------|-------------------------|------------------------------------------------|----------------|
| Test specification:   |                         | Section 15.247(d), Radiated spurious emissions |                |
| Test procedure:       |                         | ANSI C63.10 section 11.12.1                    |                |
| Test mode:            |                         | Verdict: PASS                                  |                |
| Date(s):              |                         |                                                |                |
| 03-Apr-17 - 04-Apr-17 |                         |                                                |                |
| Temperature: 23 °C    | Relative Humidity: 45 % | Air Pressure: 1010 hPa                         | Power: Battery |
| Remarks:              |                         |                                                |                |

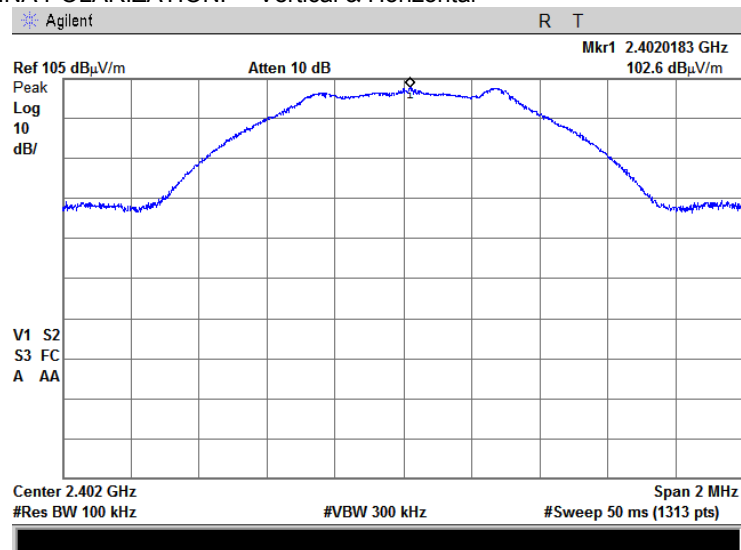
Table 7.3.6 Restricted bands according to FCC section 15.205

| MHz               | MHz                 | MHz                   | MHz             | MHz           | GHz           |
|-------------------|---------------------|-----------------------|-----------------|---------------|---------------|
| 0.09 - 0.11       | 8.37625 - 8.38675   | 73 - 74.6             | 399.9 - 410     | 2690 - 2900   | 10.6 - 12.7   |
| 0.495 - 0.505     | 8.41425 - 8.41475   | 74.8 - 75.2           | 608 - 614       | 3260 - 3267   | 13.25 - 13.4  |
| 2.1735 - 2.1905   | 12.29 - 12.293      | 108 - 121.94          | 960 - 1240      | 3332 - 3339   | 14.47 - 14.5  |
| 4.125 - 4.128     | 12.51975 - 12.52025 | 123 - 138             | 1300 - 1427     | 3345.8 - 3358 | 15.35 - 16.2  |
| 4.17725 - 4.17775 | 12.57675 - 12.57725 | 149.9 - 150.05        | 1435 - 1626.5   | 3600 - 4400   | 17.7 - 21.4   |
| 4.20725 - 4.20775 | 13.36 - 13.41       | 156.52475 - 156.52525 | 1645.5 - 1646.5 | 4500 - 5150   | 22.01 - 23.12 |
| 6.215 - 6.218     | 16.42 - 16.423      | 156.7 - 156.9         | 1660 - 1710     | 5350 - 5460   | 23.6 - 24     |
| 6.26775 - 6.26825 | 16.69475 - 16.69525 | 162.0125 - 167.17     | 1718.8 - 1722.2 | 7250 - 7750   | 31.2 - 31.8   |
| 6.31175 - 6.31225 | 16.80425 - 16.80475 | 167.72 - 173.2        | 2200 - 2300     | 8025 - 8500   | 36.43 - 36.5  |
| 8.291 - 8.294     | 25.5 - 25.67        | 240 - 285             | 2310 - 2390     | 9000 - 9200   | Above 38.6    |
| 8.362 - 8.366     | 37.5 - 38.25        | 322 - 335.4           | 2483.5 - 2500   | 9300 - 9500   |               |

|                                                                           |                                |                               |                       |
|---------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(d), Radiated spurious emissions |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                        |                                |                               |                       |
| <b>Test mode:</b> Compliance                                              |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 03-Apr-17 - 04-Apr-17                                     |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                 | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                           |                                |                               |                       |

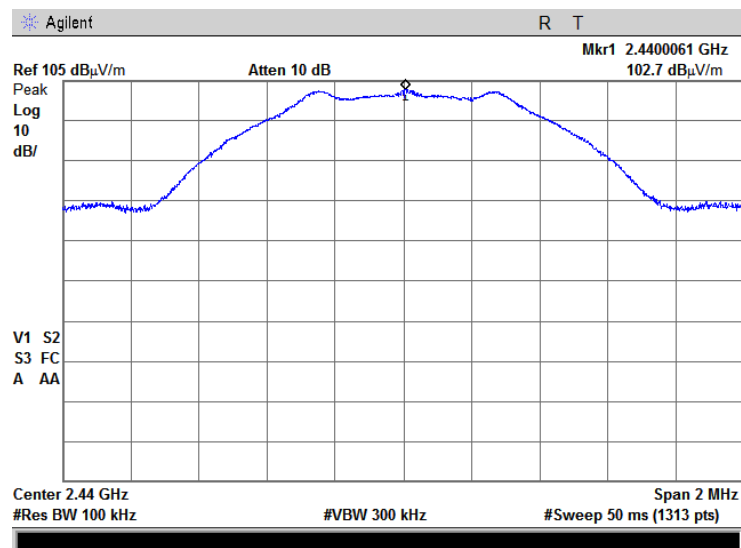
**Plot 7.3.1 Radiated emission measurements at the low carrier frequency**

TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical & Horizontal



**Plot 7.3.2 Radiated emission measurements at the mid carrier frequency**

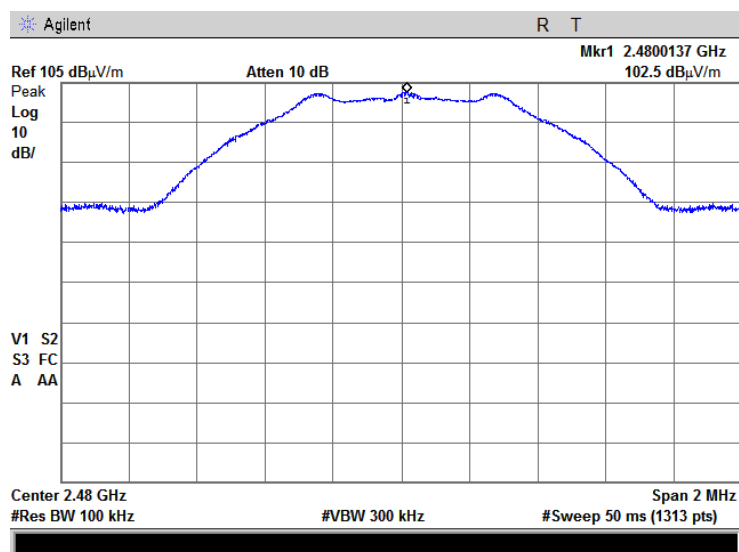
TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical & Horizontal



|                                                                           |                                |                               |                       |
|---------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(d), Radiated spurious emissions |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                        |                                |                               |                       |
| <b>Test mode:</b> Compliance                                              |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 03-Apr-17 - 04-Apr-17                                     |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                 | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                           |                                |                               |                       |

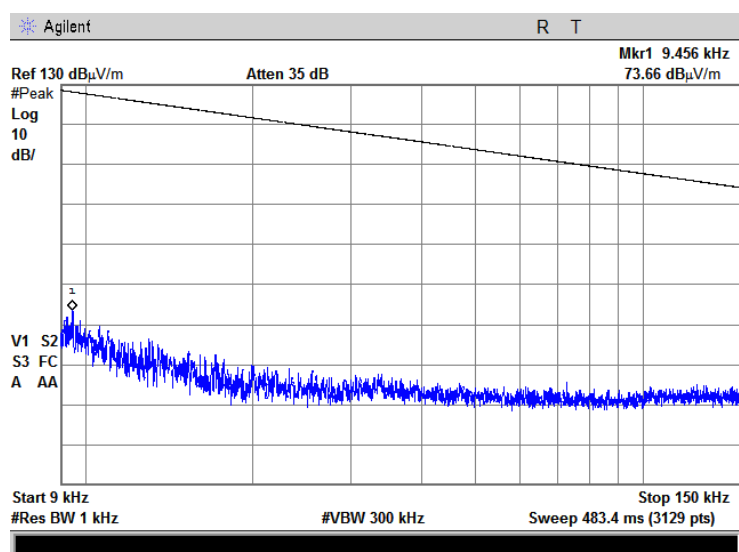
**Plot 7.3.3 Radiated emission measurements at the high carrier frequency**

TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical & Horizontal



**Plot 7.3.4 Radiated emission measurements from 9 to 150 kHz at the low, mid, high carrier frequency**

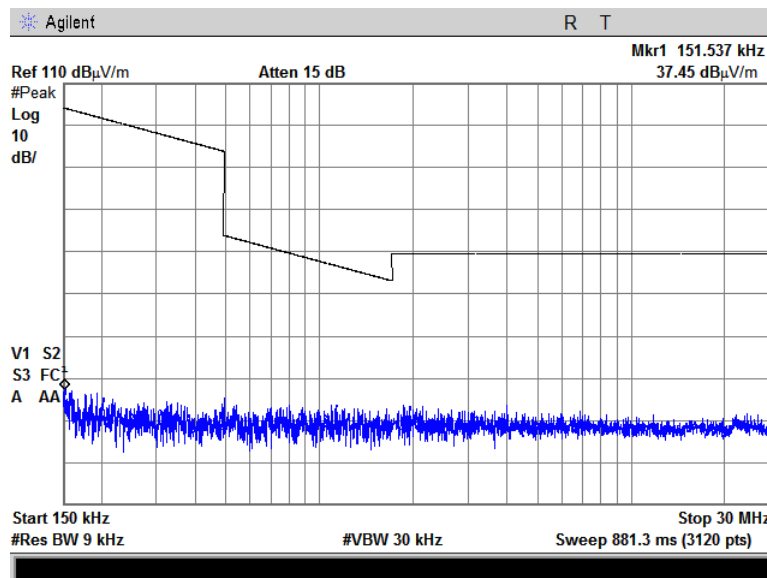
TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m



|                                                                    |                         |                        |                |
|--------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10 section 11.12.1                        |                         |                        |                |
| Test mode: Compliance                                              |                         | Verdict: PASS          |                |
| Date(s): 03-Apr-17 - 04-Apr-17                                     |                         |                        |                |
| Temperature: 23 °C                                                 | Relative Humidity: 45 % | Air Pressure: 1010 hPa | Power: Battery |
| Remarks:                                                           |                         |                        |                |

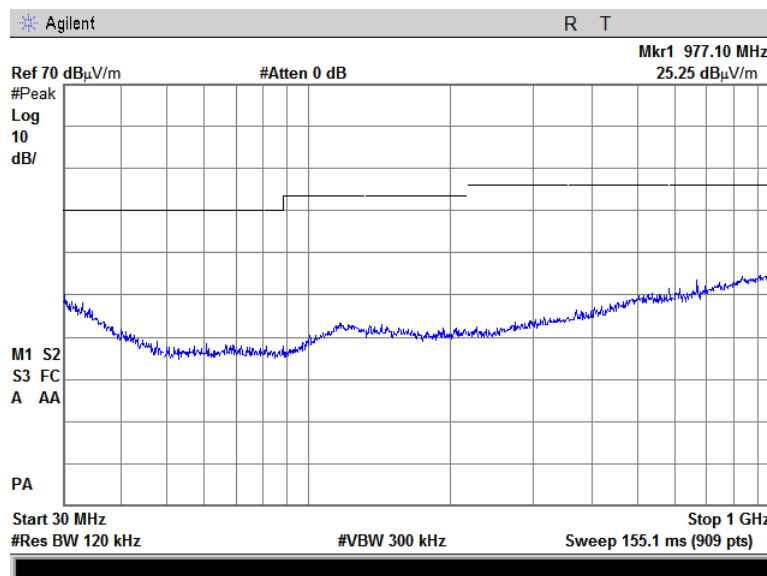
Plot 7.3.5 Radiated emission measurements from 0.15 to 30 MHz at the low, mid, high carrier frequency

TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m



Plot 7.3.6 Radiated emission measurements from 30 to 1000 MHz at the low, mid, high carrier frequency

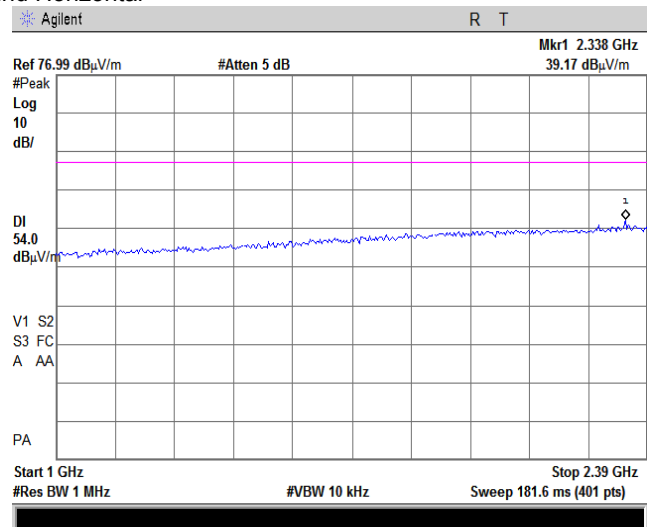
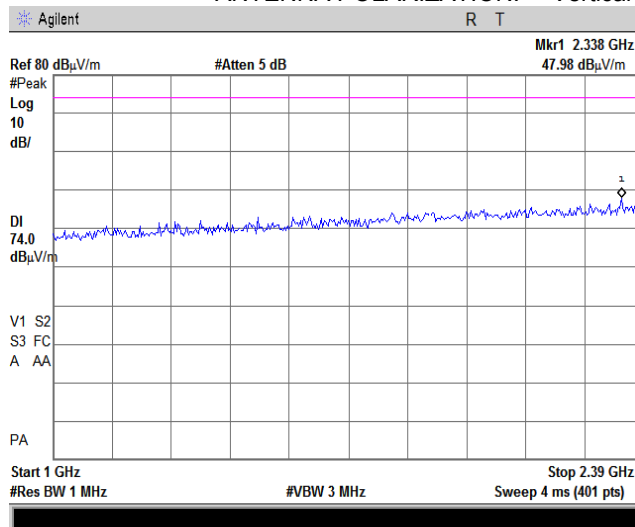
TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



|                                                                           |                                |                               |                       |
|---------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(d), Radiated spurious emissions |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                        |                                |                               |                       |
| <b>Test mode:</b> Compliance                                              |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 03-Apr-17 - 04-Apr-17                                     |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                 | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                           |                                |                               |                       |

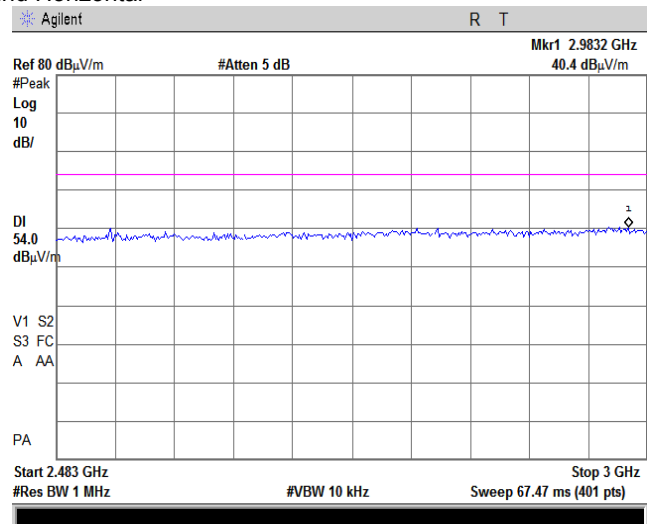
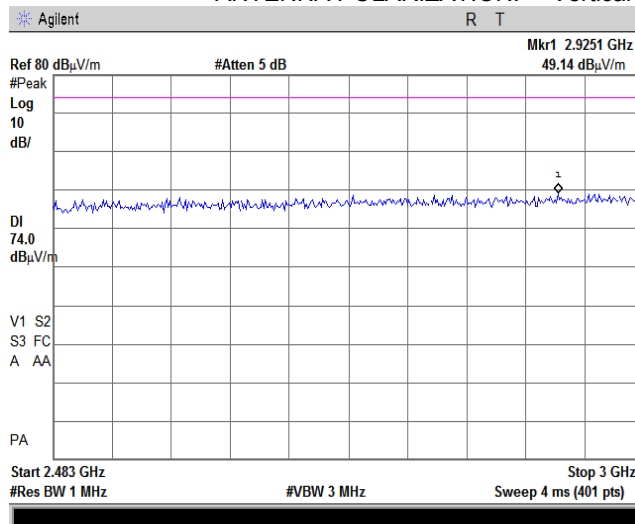
Plot 7.3.7 Radiated emission measurements from 1000 to 2390 MHz at the low carrier frequency

TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.3.8 Radiated emission measurements from 2483.5 to 3000 MHz at the low carrier frequency

TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



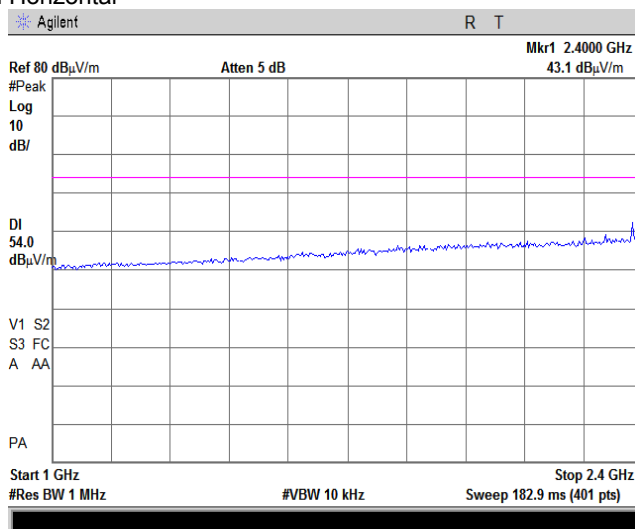
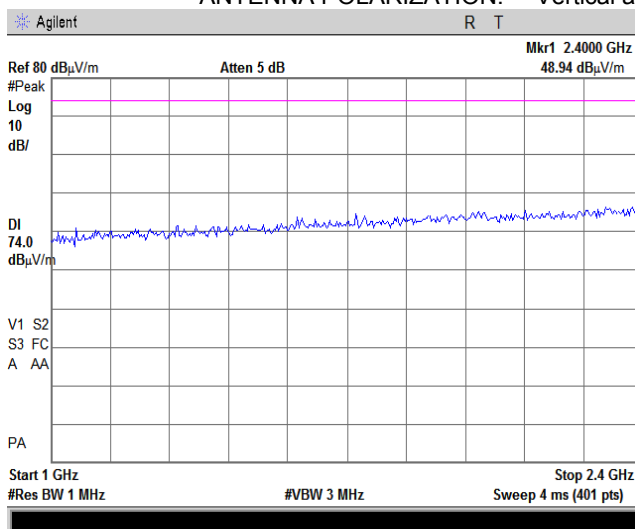


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|                                                                    |                         |                        |                |
|--------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10 section 11.12.1                        |                         |                        |                |
| Test mode: Compliance                                              |                         | Verdict: PASS          |                |
| Date(s): 03-Apr-17 - 04-Apr-17                                     |                         |                        |                |
| Temperature: 23 °C                                                 | Relative Humidity: 45 % | Air Pressure: 1010 hPa | Power: Battery |
| Remarks:                                                           |                         |                        |                |

Plot 7.3.9 Radiated emission measurements from 1000 to 2400 MHz at the mid carrier frequency

TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



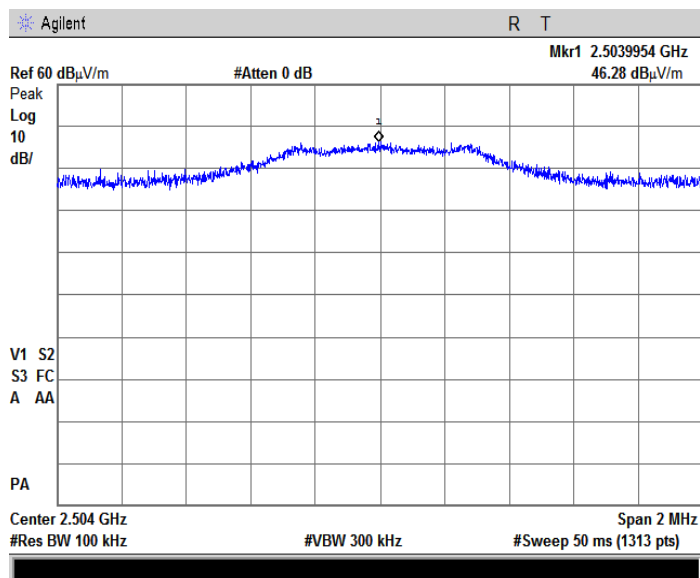
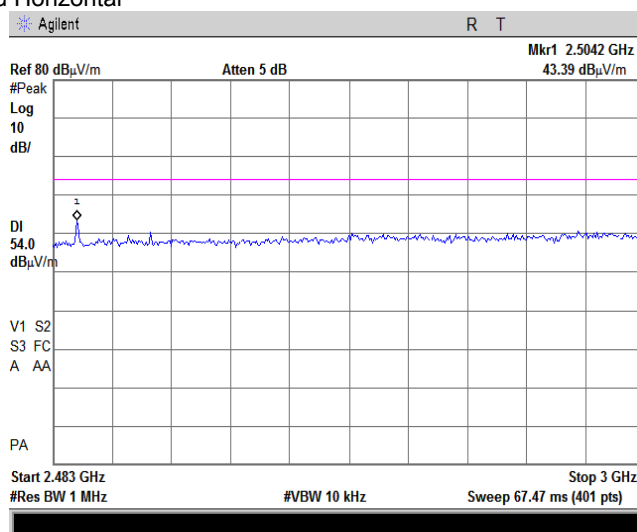
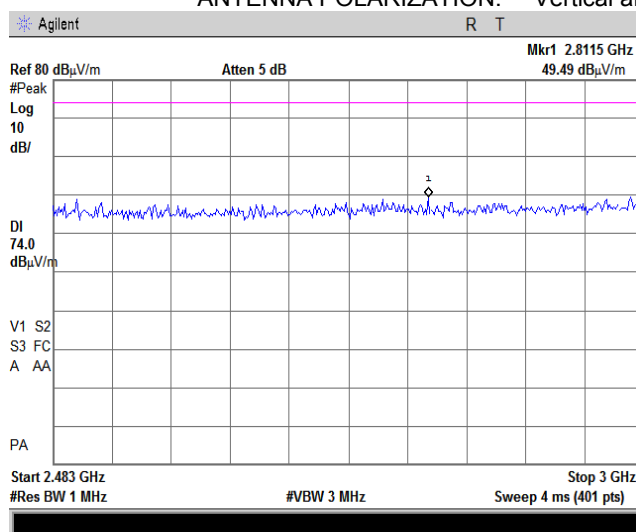


HERMON LABORATORIES

|                                                                    |                         |                        |                |
|--------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10 section 11.12.1                        |                         |                        |                |
| Test mode: Compliance                                              |                         | Verdict: PASS          |                |
| Date(s): 03-Apr-17 - 04-Apr-17                                     |                         |                        |                |
| Temperature: 23 °C                                                 | Relative Humidity: 45 % | Air Pressure: 1010 hPa | Power: Battery |
| Remarks:                                                           |                         |                        |                |

Plot 7.3.10 Radiated emission measurements from 2483.5 to 3000 MHz at the mid carrier frequency

TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



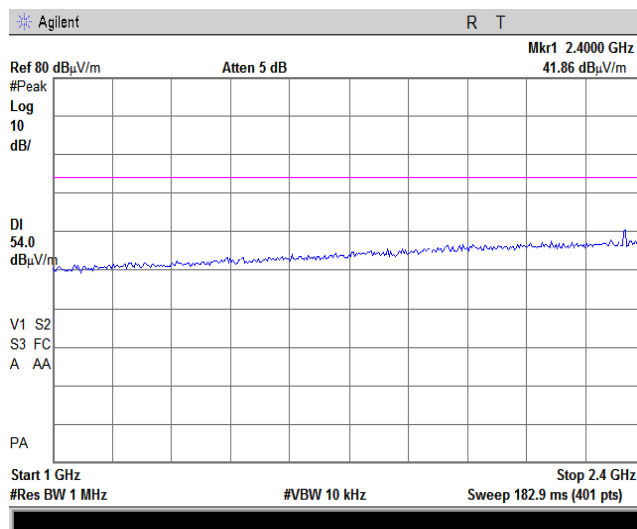
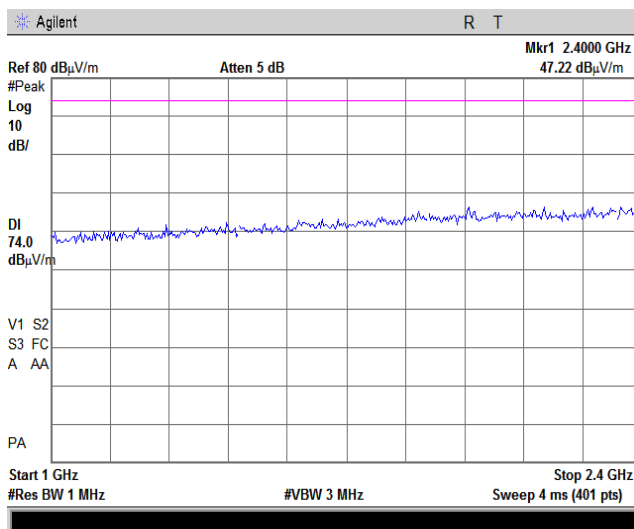


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|                                                                    |                         |                        |                |
|--------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10 section 11.12.1                        |                         |                        |                |
| Test mode: Compliance                                              |                         | Verdict: PASS          |                |
| Date(s): 03-Apr-17 - 04-Apr-17                                     |                         |                        |                |
| Temperature: 23 °C                                                 | Relative Humidity: 45 % | Air Pressure: 1010 hPa | Power: Battery |
| Remarks:                                                           |                         |                        |                |

Plot 7.3.11 Radiated emission measurements from 1000 to 2400 MHz at the high carrier frequency

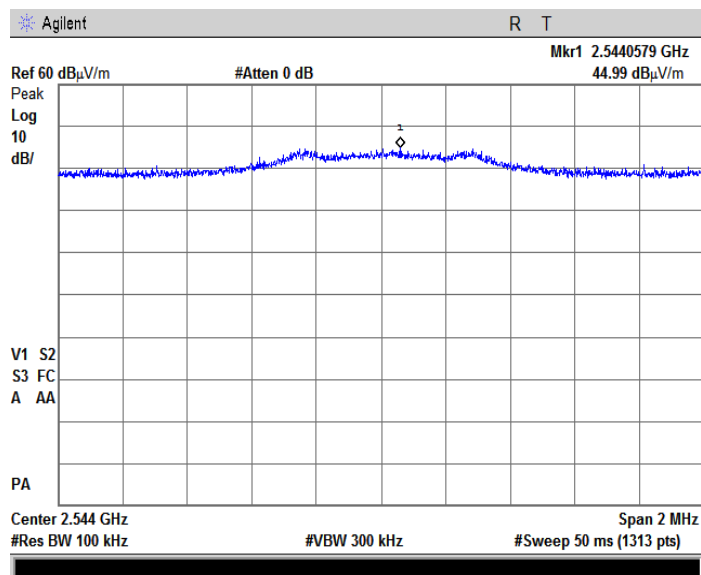
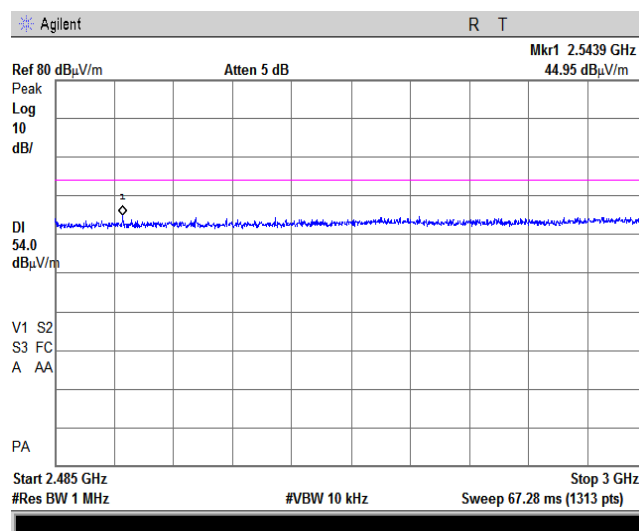
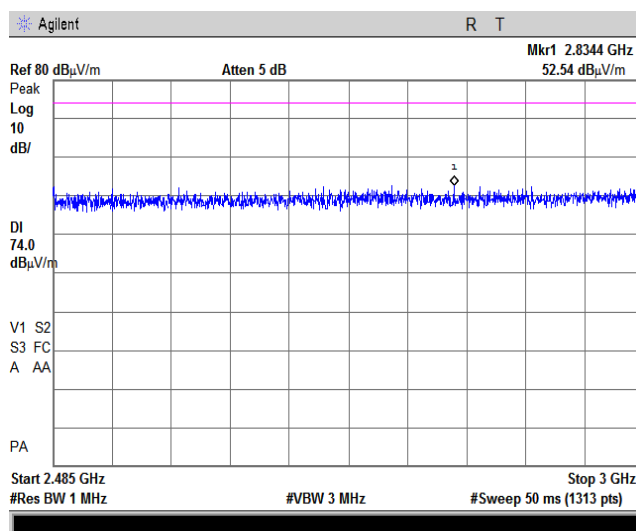
TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



|                                                                           |                                |                               |                       |
|---------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(d), Radiated spurious emissions |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                        |                                |                               |                       |
| <b>Test mode:</b> Compliance                                              |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 03-Apr-17 - 04-Apr-17                                     |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                 | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                           |                                |                               |                       |

Plot 7.3.12 Radiated emission measurements from 2485 to 3000 MHz at the high carrier frequency

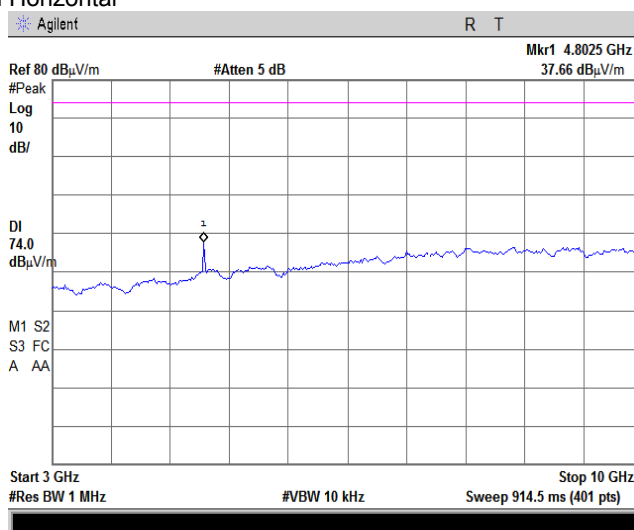
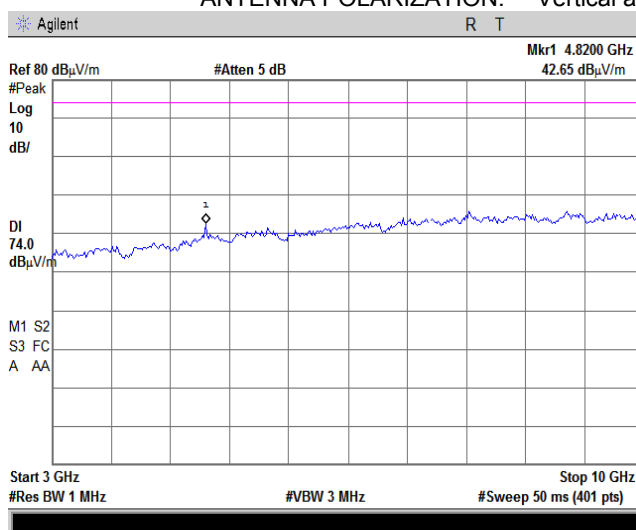
TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



|                                                                           |                                |                               |                       |
|---------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(d), Radiated spurious emissions |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                        |                                |                               |                       |
| <b>Test mode:</b> Compliance                                              |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 03-Apr-17 - 04-Apr-17                                     |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                 | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                           |                                |                               |                       |

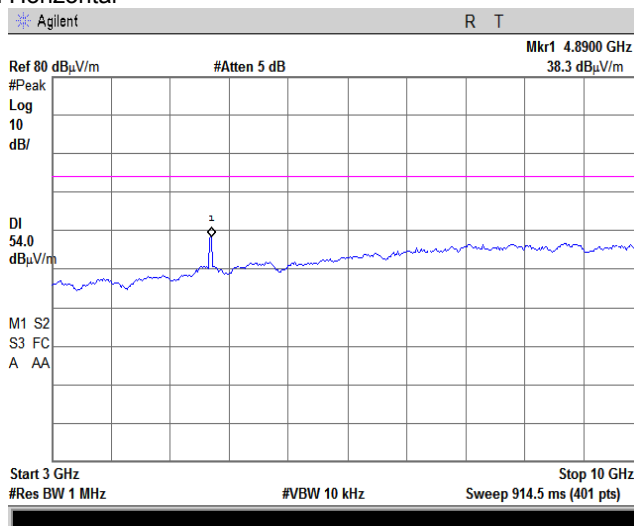
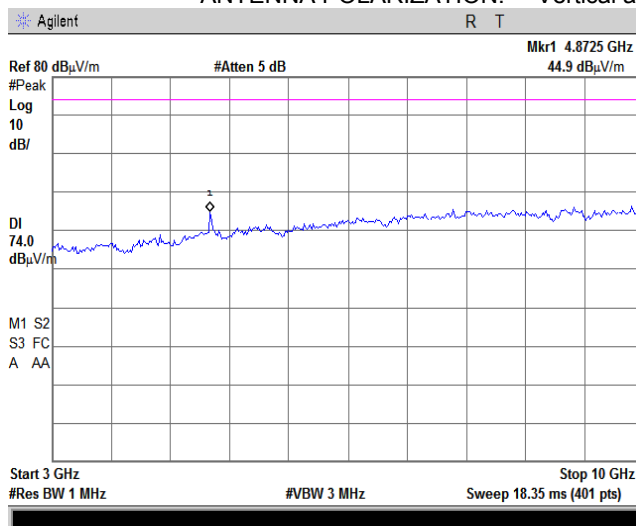
Plot 7.3.13 Radiated emission measurements from 3000 to 10000 MHz at the low carrier frequency

TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.3.14 Radiated emission measurements from 3000 to 10000 MHz at the mid carrier frequency

TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



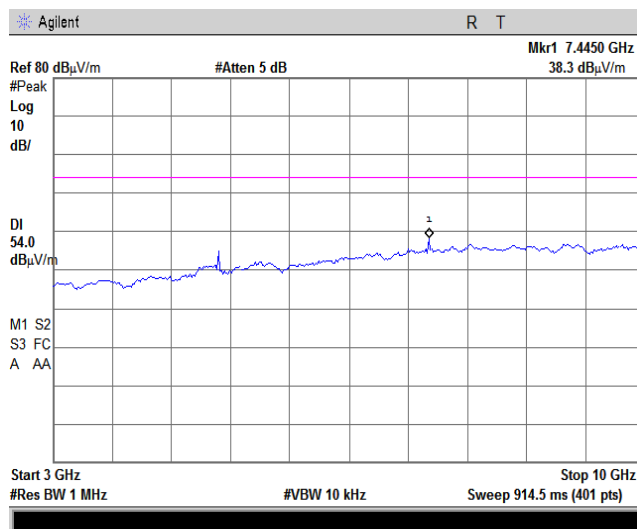
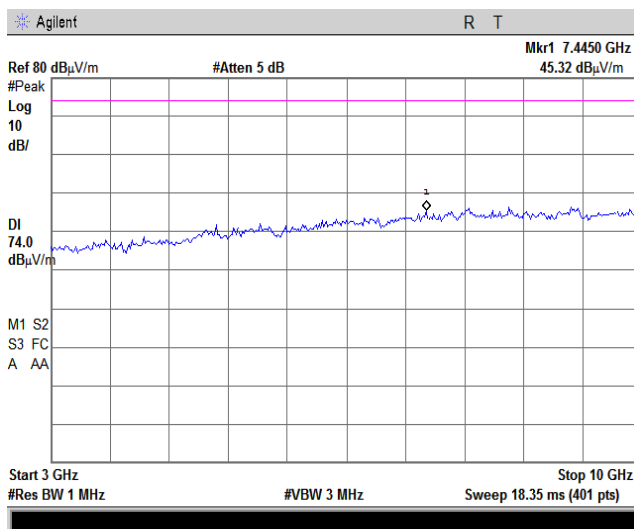


HERMON LABORATORIES

|                                                                    |                         |                        |                |
|--------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10 section 11.12.1                        |                         |                        |                |
| Test mode: Compliance                                              |                         | Verdict: PASS          |                |
| Date(s): 03-Apr-17 - 04-Apr-17                                     |                         |                        |                |
| Temperature: 23 °C                                                 | Relative Humidity: 45 % | Air Pressure: 1010 hPa | Power: Battery |
| Remarks:                                                           |                         |                        |                |

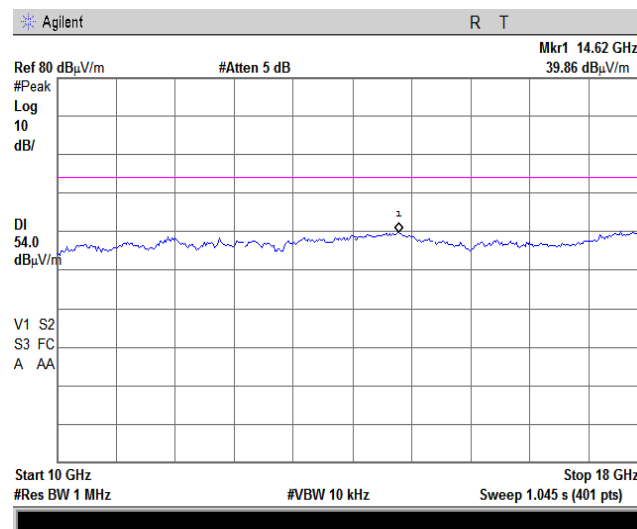
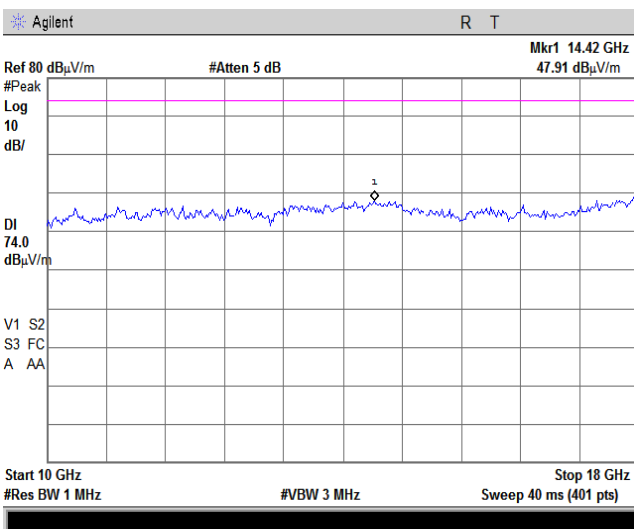
Plot 7.3.15 Radiated emission measurements from 3000 to 10000 MHz at the high carrier frequency

TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.3.16 Radiated emission measurements from 10000 to 18000 MHz at the low carrier frequency

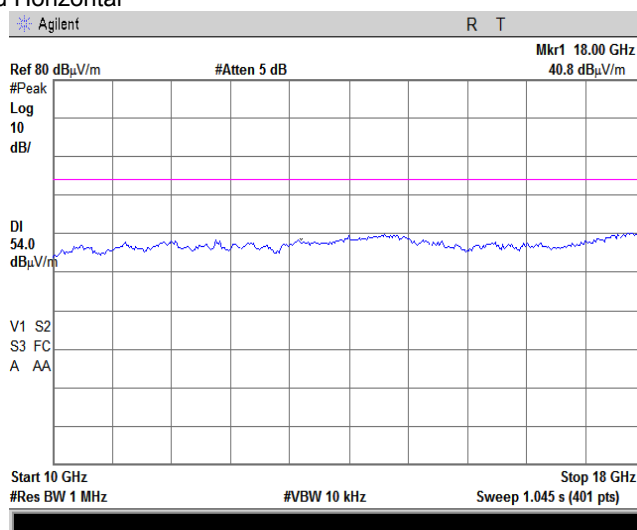
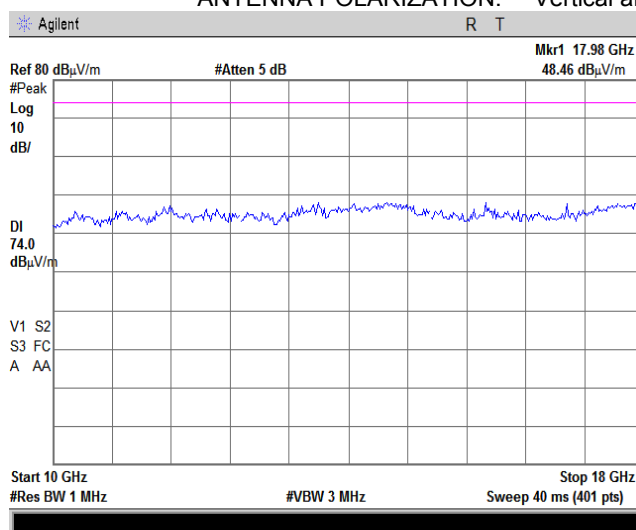
TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



|                                                                           |                                |                               |                       |
|---------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(d), Radiated spurious emissions |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                        |                                |                               |                       |
| <b>Test mode:</b> Compliance                                              |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 03-Apr-17 - 04-Apr-17                                     |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                 | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                           |                                |                               |                       |

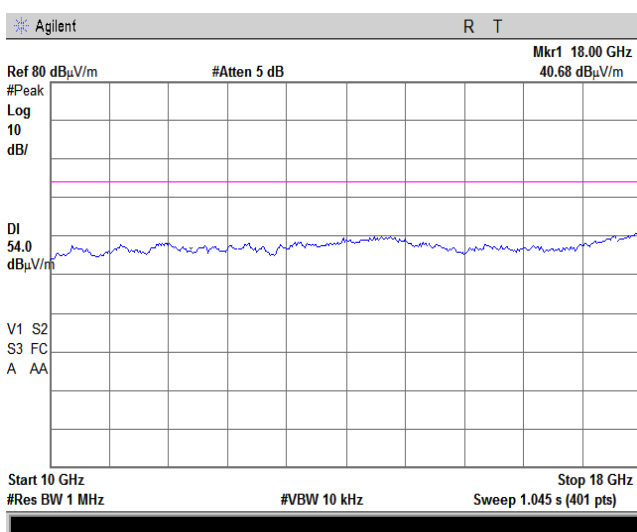
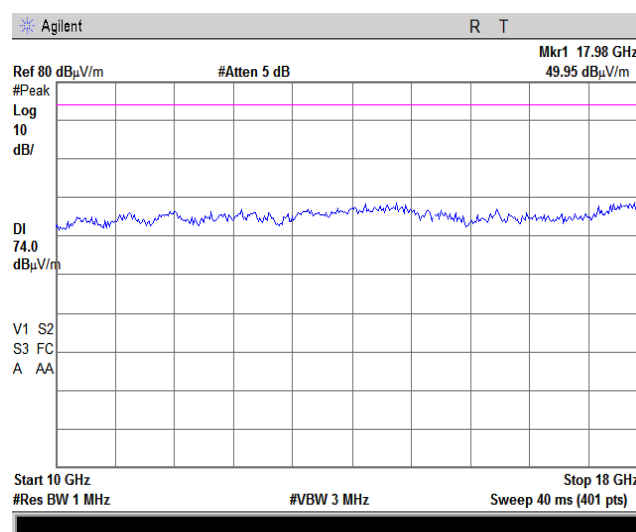
Plot 7.3.17 Radiated emission measurements from 10000 to 18000 MHz at the mid carrier frequency

TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.3.18 Radiated emission measurements from 10000 to 18000 MHz at the high carrier frequency

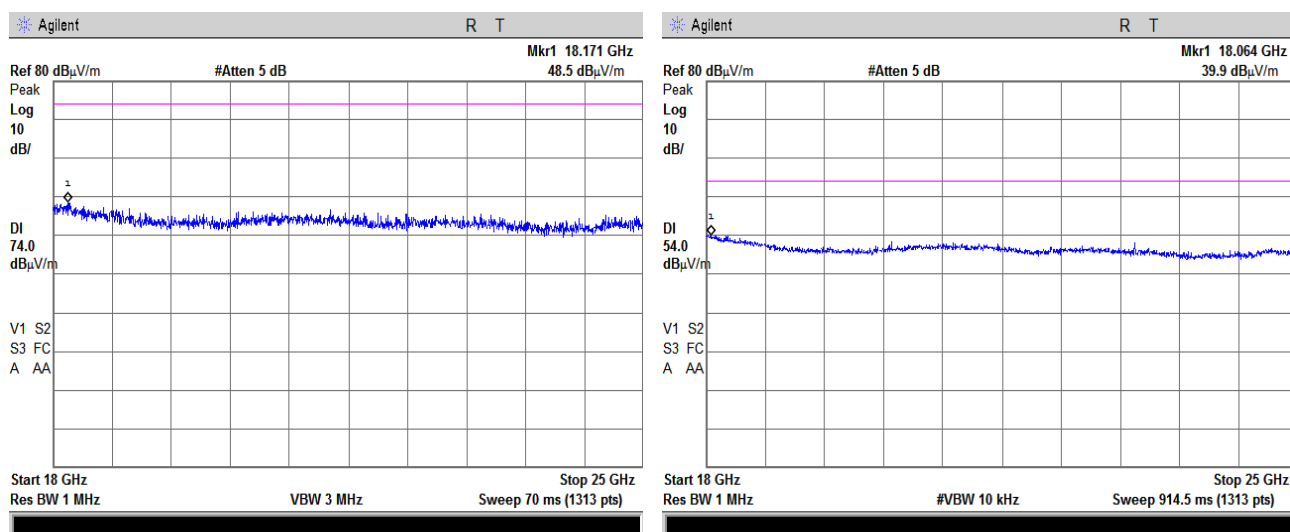
TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



|                                                                           |                                |                               |                       |
|---------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(d), Radiated spurious emissions |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                        |                                |                               |                       |
| <b>Test mode:</b> Compliance                                              |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 03-Apr-17 - 04-Apr-17                                     |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                 | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                           |                                |                               |                       |

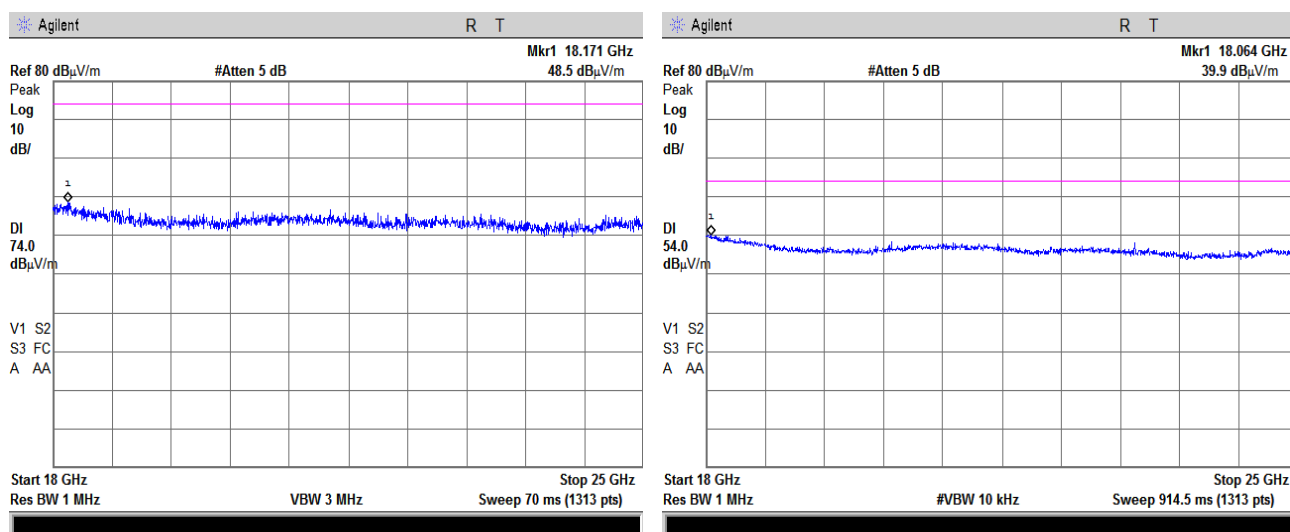
Plot 7.3.19 Radiated emission measurements from 18000 to 25000 MHz **at low, mid, the high** carrier frequency

TEST SITE: OATS  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.3.20 Radiated emission measurements from 18000 to 25000 MHz at low carrier frequency

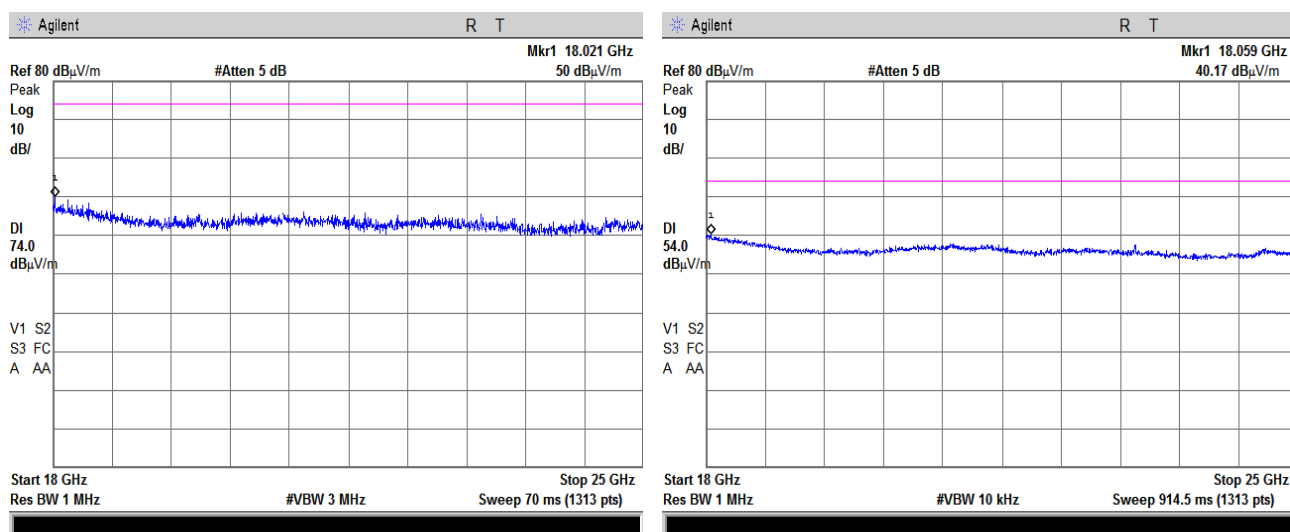
TEST SITE: OATS  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



|                                                                           |                                |                               |                       |
|---------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(d), Radiated spurious emissions |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.12.1                        |                                |                               |                       |
| <b>Test mode:</b> Compliance                                              |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 03-Apr-17 - 04-Apr-17                                     |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                 | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                           |                                |                               |                       |

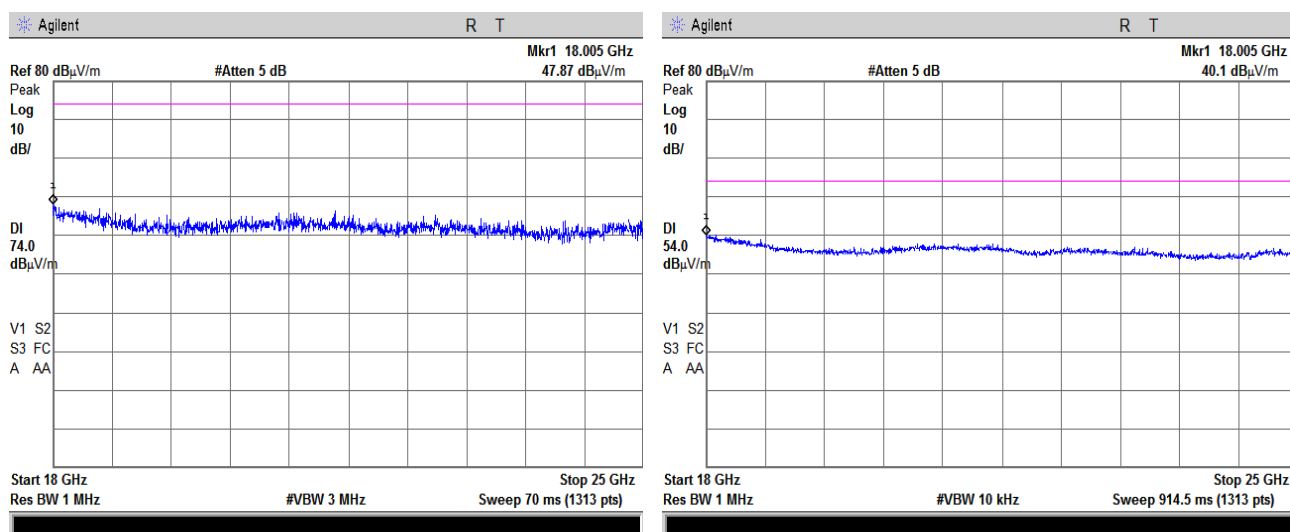
**Plot 7.3.21 Radiated emission measurements from 18000 to 25000 MHz at mid carrier frequency**

TEST SITE: OATS  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



**Plot 7.3.22 Radiated emission measurements from 18000 to 25000 MHz at high carrier frequency**

TEST SITE: OATS  
TEST DISTANCE: 3 m  
ANTENNA POLARIZATION: Vertical and Horizontal



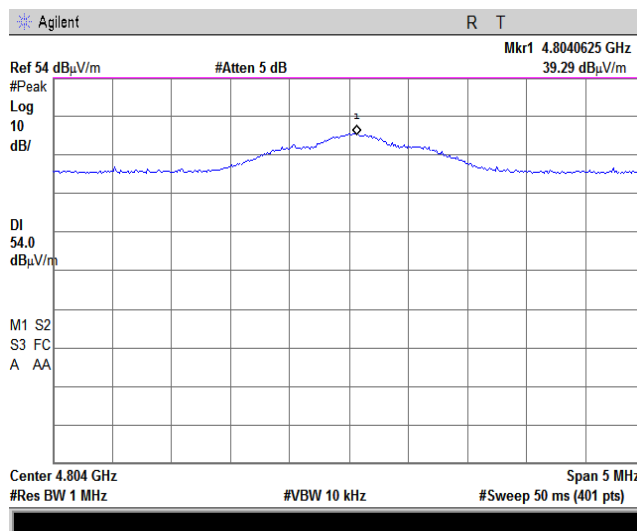
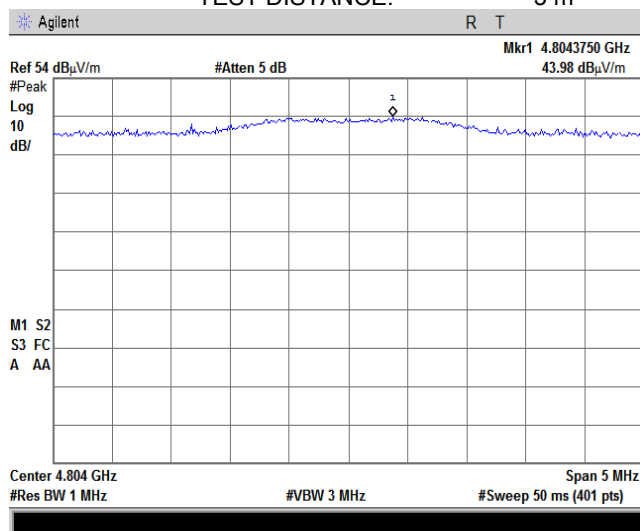


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|--------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10 section 11.12.1                        |                         |                        |                |
| Test mode: Compliance                                              |                         | Verdict: PASS          |                |
| Date(s): 03-Apr-17 - 04-Apr-17                                     |                         |                        |                |
| Temperature: 23 °C                                                 | Relative Humidity: 45 % | Air Pressure: 1010 hPa | Power: Battery |
| Remarks:                                                           |                         |                        |                |

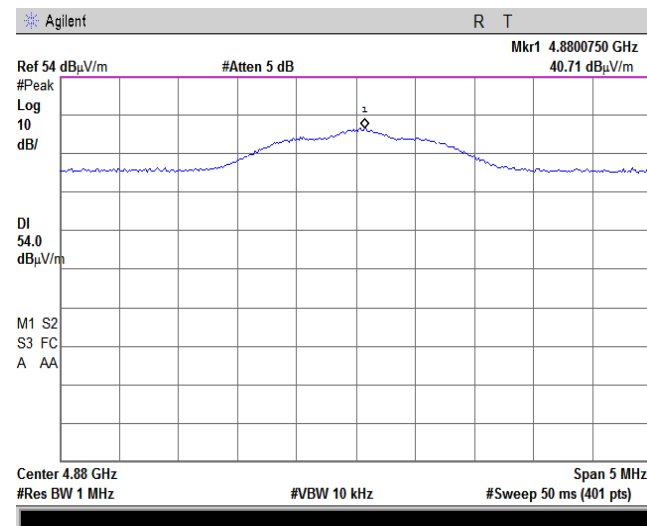
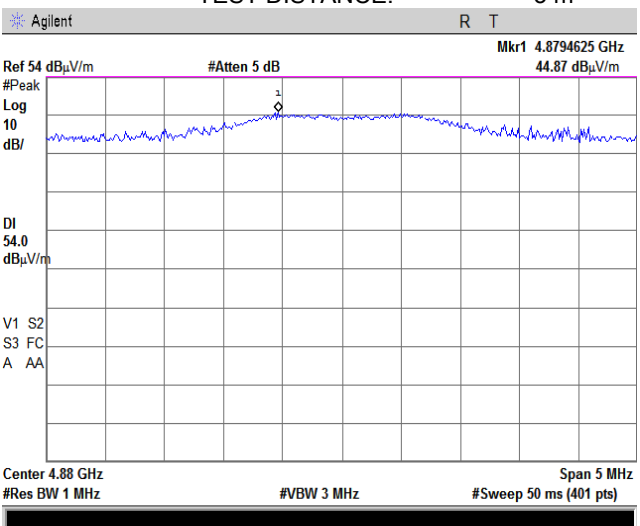
Plot 7.3.23 Radiated emission measurements at the second harmonic of low carrier frequency

TEST SITE: OATS  
TEST DISTANCE: 3 m



Plot 7.3.24 Radiated emission measurements at the second harmonic of mid carrier frequency

TEST SITE: OATS  
TEST DISTANCE: 3 m



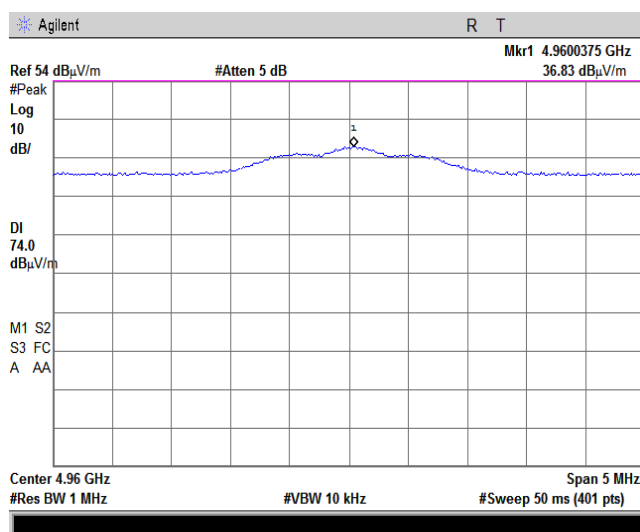
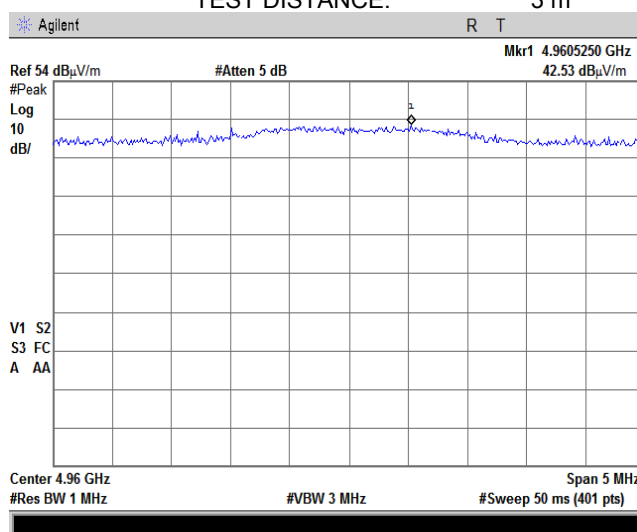


HERMON LABORATORIES

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|--------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10 section 11.12.1                        |                         |                        |                |
| Test mode: Compliance                                              |                         | Verdict: PASS          |                |
| Date(s): 03-Apr-17 - 04-Apr-17                                     |                         |                        |                |
| Temperature: 23 °C                                                 | Relative Humidity: 45 % | Air Pressure: 1010 hPa | Power: Battery |
| Remarks:                                                           |                         |                        |                |

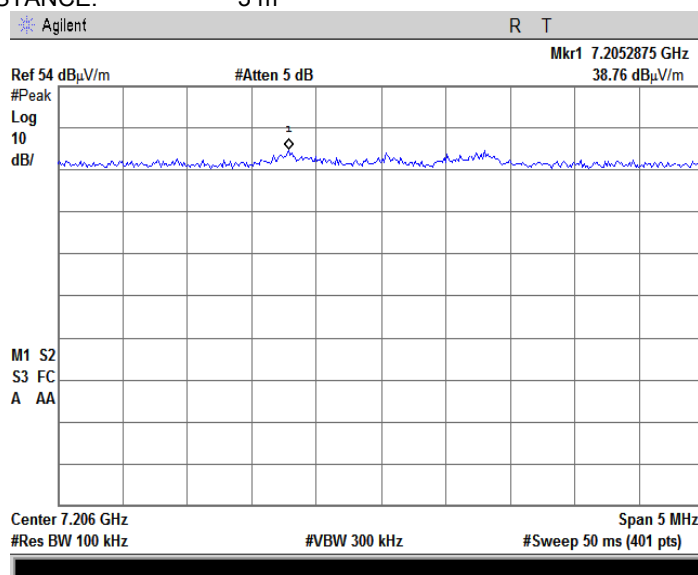
Plot 7.3.25 Radiated emission measurements at the second harmonic of high carrier frequency

TEST SITE: OATS  
TEST DISTANCE: 3 m



Plot 7.3.26 Radiated emission measurements at the third harmonic of low carrier frequency

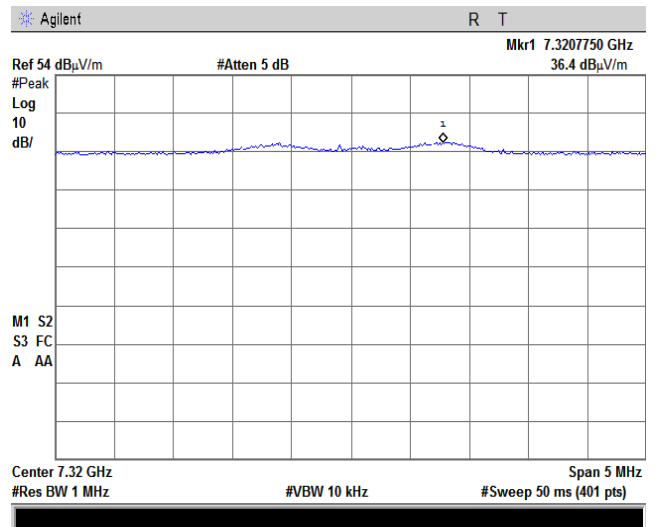
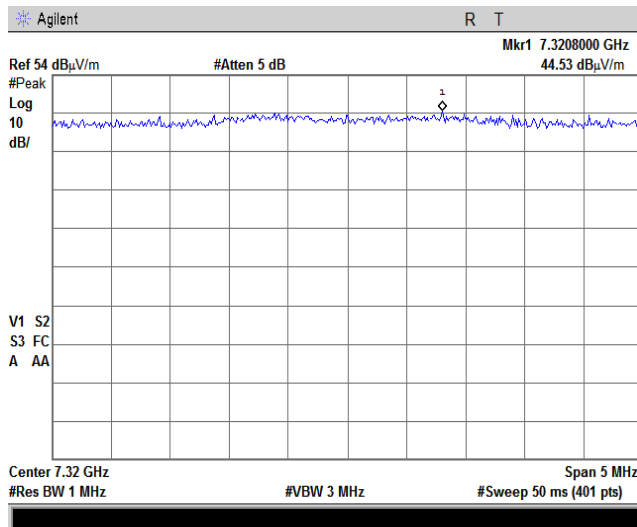
TEST SITE: OATS  
TEST DISTANCE: 3 m



|                                                                    |                         |                        |                |
|--------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10 section 11.12.1                        |                         |                        |                |
| Test mode: Compliance                                              |                         | Verdict: PASS          |                |
| Date(s): 03-Apr-17 - 04-Apr-17                                     |                         |                        |                |
| Temperature: 23 °C                                                 | Relative Humidity: 45 % | Air Pressure: 1010 hPa | Power: Battery |
| Remarks:                                                           |                         |                        |                |

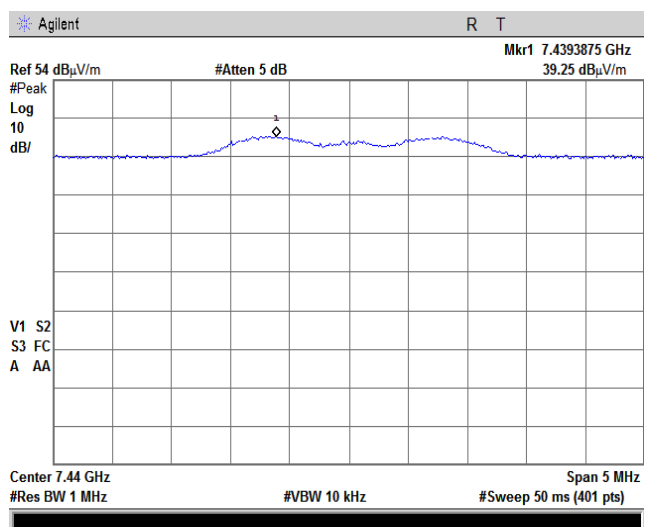
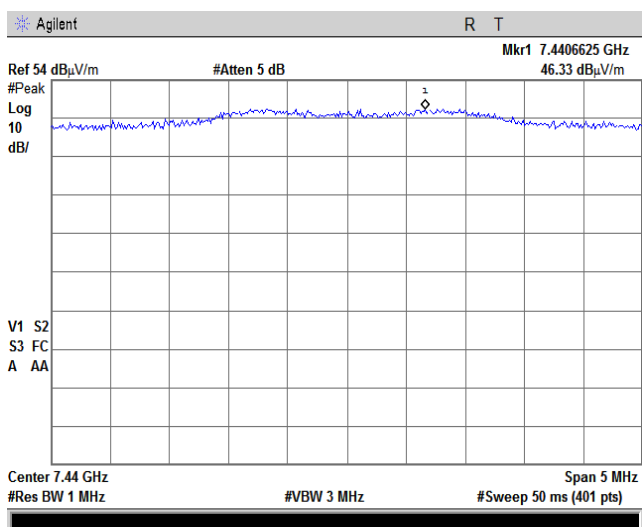
**Plot 7.3.27 Radiated emission measurements at the third harmonic of mid carrier frequency**

TEST SITE: OATS  
TEST DISTANCE: 3 m



**Plot 7.3.28 Radiated emission measurements at the third harmonic of high carrier frequency**

TEST SITE: OATS  
TEST DISTANCE: 3 m

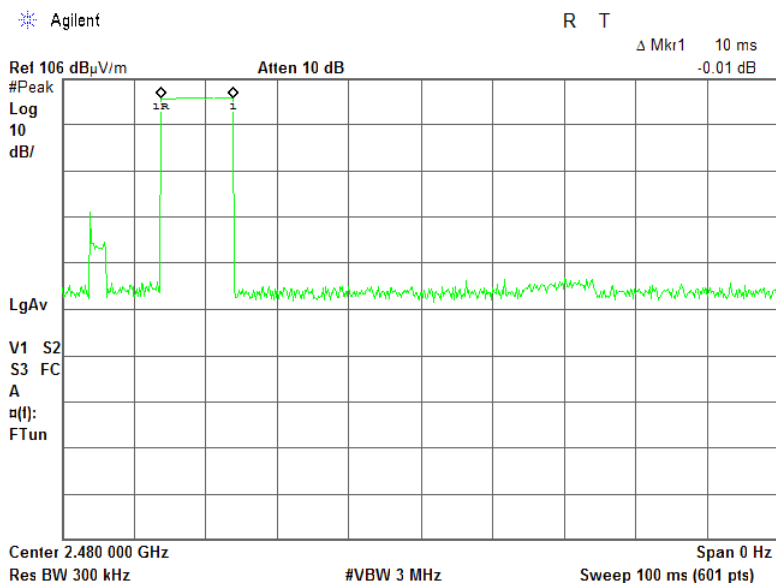




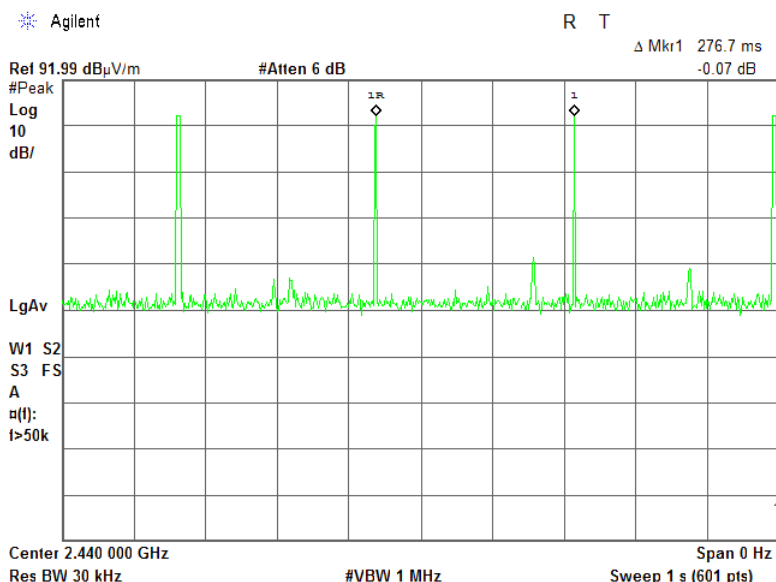
HERMON LABORATORIES

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|--------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), Radiated spurious emissions |                         |                        |                |
| Test procedure: ANSI C63.10 section 11.12.1                        |                         |                        |                |
| Test mode: Compliance                                              |                         | Verdict: PASS          |                |
| Date(s): 03-Apr-17 - 04-Apr-17                                     |                         |                        |                |
| Temperature: 23 °C                                                 | Relative Humidity: 45 % | Air Pressure: 1010 hPa | Power: Battery |
| Remarks:                                                           |                         |                        |                |

Plot 7.3.29 Transmission pulse duration



Plot 7.3.30 Transmission pulse period



|                                                                          |                                |                               |                       |
|--------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> <b>Section 15.247(d), Band edge emissions</b> |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.13.3.3                     |                                |                               |                       |
| <b>Test mode:</b> Compliance                                             |                                | <b>Verdict:</b> <b>PASS</b>   |                       |
| <b>Date(s):</b> 02-Apr-17 - 04-Apr-17                                    |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                          |                                |                               |                       |

## 7.4 Band edge radiated emissions

### 7.4.1 General

This test was performed to measure emissions, radiated from the EUT at the assigned frequency band edges. Specification test limits are given in Table 7.4.1.

Table 7.4.1 Band edge emission limits

| Assigned frequency, MHz | Attenuation below carrier*, dBc | Field strength at 3 m within restricted bands, dB(μV/m) |         |
|-------------------------|---------------------------------|---------------------------------------------------------|---------|
|                         |                                 | Peak                                                    | Average |
| 902.0 – 928.0           | 20.0                            | 74.0                                                    | 54.0    |
| 2400.0 – 2483.5         |                                 |                                                         |         |
| 5725.0 – 5850.0         |                                 |                                                         |         |

\* - Band edge emission limit is provided in terms of attenuation below the peak of modulated carrier measured with the same resolution bandwidth.

### 7.4.2 Test procedure

- 7.4.2.1 The EUT was set up as shown in Figure 7.4.1, energized normally modulated at the maximum data rate and its proper operation was checked.
- 7.4.2.2 The EUT was adjusted to produce maximum available to end user RF output power at the lowest carrier frequency.
- 7.4.2.3 The spectrum analyzer span was set to capture the carrier frequency and associated modulation products. The resolution bandwidth was set wider than 1 % of the frequency span.
- 7.4.2.4 The spectrum analyzer was set in max hold mode and allowed trace to stabilize. The highest emission level within the authorized band was measured.
- 7.4.2.5 The maximum band edge emission and modulation product outside of the band were measured as provided in Table 7.4.2 and associated plots and referenced to the highest emission level measured within the authorized band.
- 7.4.2.6 The above procedure was repeated with the EUT adjusted to produce maximum RF output power at the highest carrier frequency.

Figure 7.4.1 Band edge emission test setup





|                                                                          |                                |                               |                       |
|--------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> <b>Section 15.247(d), Band edge emissions</b> |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.13.3.3                     |                                |                               |                       |
| <b>Test mode:</b> Compliance                                             |                                | <b>Verdict:</b> <b>PASS</b>   |                       |
| <b>Date(s):</b> 02-Apr-17 - 04-Apr-17                                    |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                          |                                |                               |                       |

Table 7.4.2 Band edge emission test results

ASSIGNED FREQUENCY RANGE: 2400-2483.5 MHz  
 DETECTOR USED: Peak  
 MODULATION: BLE(GFSK)  
 MODULATING SIGNAL: PRBS  
 BIT RATE: 1 Mbps  
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum  
 VIDEO BANDWIDTH: ≥ RBW

**Outside restricted bands**

| Frequency MHz | Band edge emission, dBm | Emission at carrier, dBm | Attenuation below carrier, dBc | Limit, dBc | Margin, dB* | Verdict |
|---------------|-------------------------|--------------------------|--------------------------------|------------|-------------|---------|
| 2400.0        | 66.27                   | 103.1                    | 36.83                          | 20         | 16.83       | Pass    |

**In the restricted bands**

| Frequency MHz | Peak field strength(VBW=3 MHz) |                 |            | Average field strength(VBW>10 Hz) |                 |            | Verdict |
|---------------|--------------------------------|-----------------|------------|-----------------------------------|-----------------|------------|---------|
|               | Measured, dB(μV/m)             | Limit, dB(μV/m) | Margin, dB | Measured, dB(μV/m)                | Limit, dB(μV/m) | Margin, dB |         |
| 2338.2        | 62.41                          | 74              | -11.59     | 45.34                             | 54              | -8.66      | Pass    |
| 2483.5        | 72.42                          | 74              | -1.58      | 47.88                             | 54              | -6.12      |         |

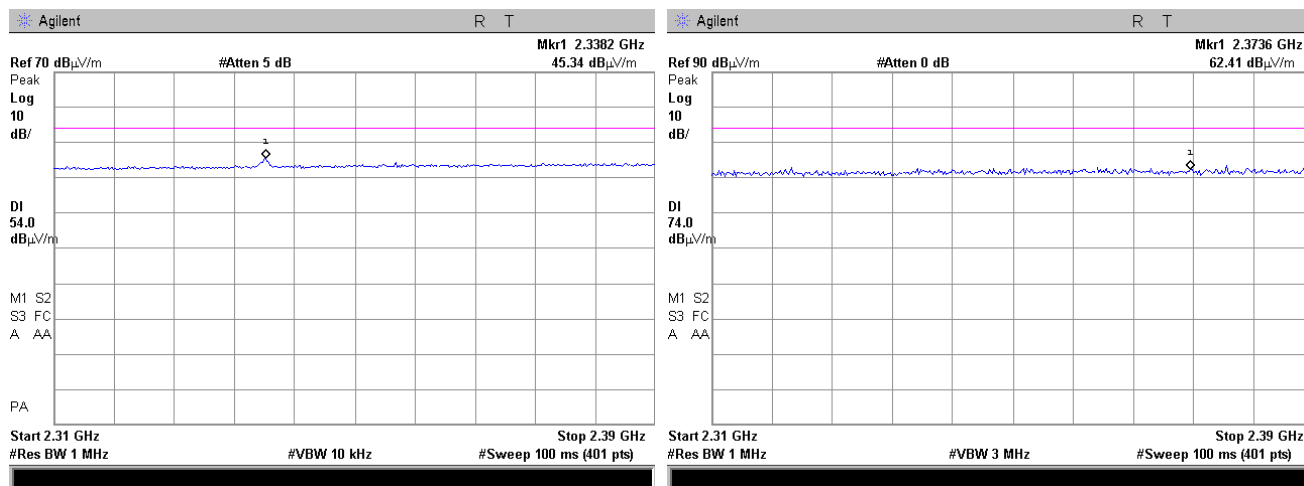
**Reference numbers of test equipment used**

|         |         |         |  |  |  |  |  |
|---------|---------|---------|--|--|--|--|--|
| HL 2909 | HL 4114 | HL 5103 |  |  |  |  |  |
|---------|---------|---------|--|--|--|--|--|

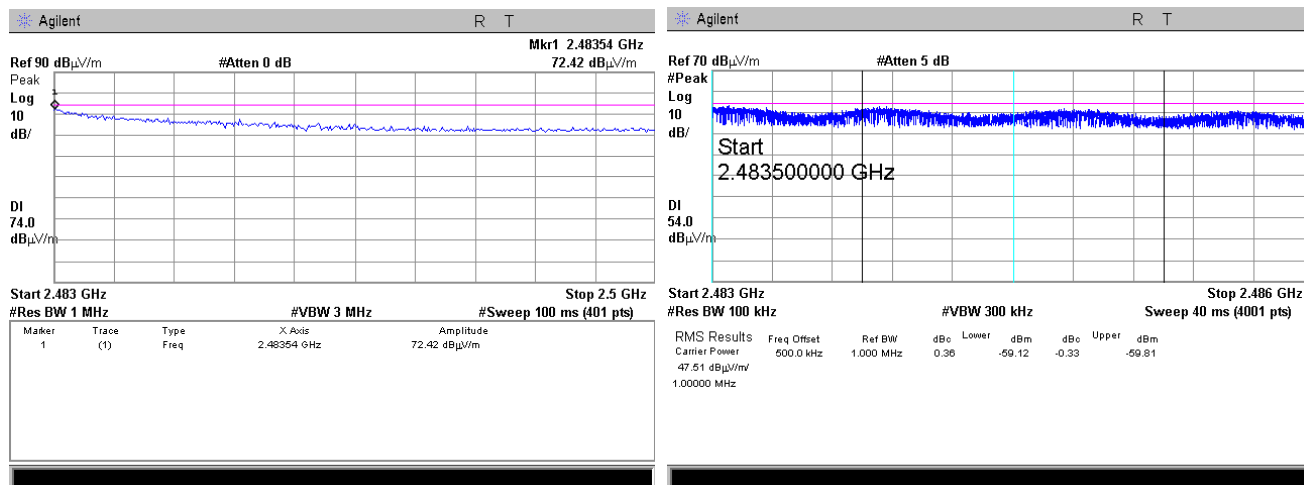
Full description is given in Appendix A.

|                                                            |                         |                        |                |
|------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), Band edge emissions |                         |                        |                |
| Test procedure: ANSI C63.10 section 11.13.3.3              |                         |                        |                |
| Test mode: Compliance                                      |                         | Verdict: PASS          |                |
| Date(s): 02-Apr-17 - 04-Apr-17                             |                         |                        |                |
| Temperature: 23 °C                                         | Relative Humidity: 45 % | Air Pressure: 1010 hPa | Power: Battery |
| Remarks:                                                   |                         |                        |                |

Plot 7.4.1 The highest band edge emission within the restricted band at low carrier frequency

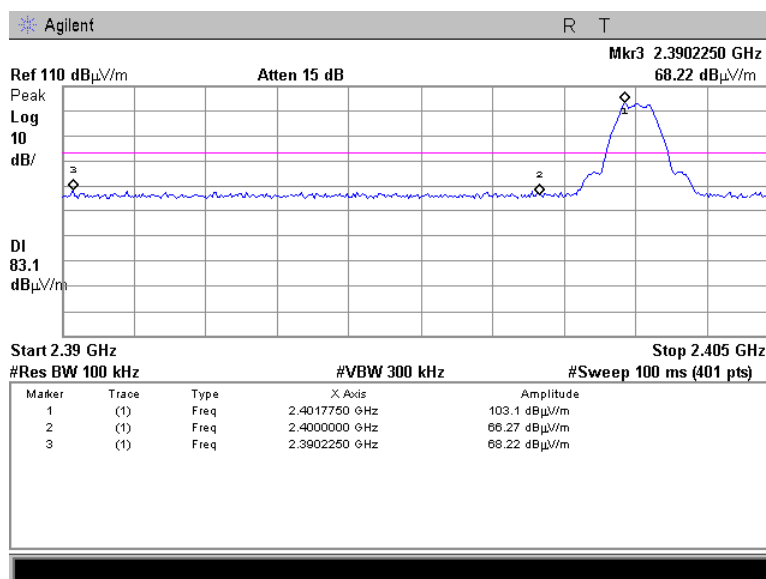


Plot 7.4.2 The highest band edge emission within the restricted band at high carrier frequency

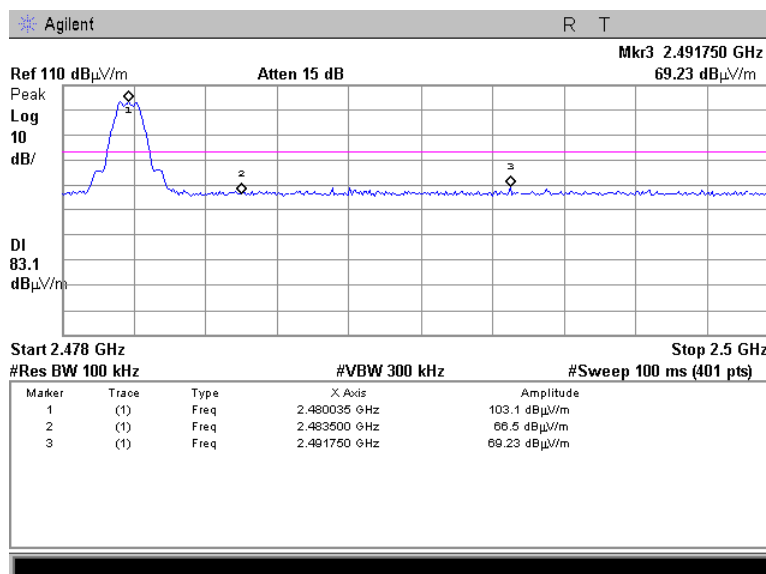


|                                                                   |                                |                               |                       |
|-------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification: Section 15.247(d), Band edge emissions</b> |                                |                               |                       |
| <b>Test procedure: ANSI C63.10 section 11.13.3.3</b>              |                                |                               |                       |
| <b>Test mode: Compliance</b>                                      |                                | <b>Verdict: PASS</b>          |                       |
| <b>Date(s): 02-Apr-17 - 04-Apr-17</b>                             |                                |                               |                       |
| <b>Temperature: 23 °C</b>                                         | <b>Relative Humidity: 45 %</b> | <b>Air Pressure: 1010 hPa</b> | <b>Power: Battery</b> |
| <b>Remarks:</b>                                                   |                                |                               |                       |

**Plot 7.4.3 The highest band edge emission at low carrier frequency**



**Plot 7.4.4 The highest band edge emission at high carrier frequency**





|                                                                                     |                                |                               |                       |
|-------------------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> <b>Section 15.247(d), Maximum power spectral density</b> |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.10.2                                  |                                |                               |                       |
| <b>Test mode:</b> Compliance                                                        |                                | <b>Verdict:</b> <b>PASS</b>   |                       |
| <b>Date(s):</b> 03-Apr-17                                                           |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                           | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                                     |                                |                               |                       |

## 7.5 Maximum power spectral density (PSD)

### 7.5.1 General

This test was performed to measure the peak spectral power density radiated by the transmitter RF antenna. Specification test limits are given in Table 7.5.1.

Table 7.5.1 Peak spectral power density limits

| Assigned frequency range, MHz | Measurement bandwidth, kHz | Peak spectral power density, dBm | Equivalent field strength limit @ 3m, dB(μV/m)* |
|-------------------------------|----------------------------|----------------------------------|-------------------------------------------------|
| 902.0 – 928.0                 | 3.0                        | 8.0                              | 103.2                                           |
| 2400.0 – 2483.5               |                            |                                  |                                                 |
| 5725.0 – 5850.0               |                            |                                  |                                                 |

\* - Equivalent field strength limit was calculated from the peak spectral power density as follows:  $E = \sqrt{30 \times P} / r$ , where P is peak spectral power density and r is antenna to EUT distance in meters.

### 7.5.2 Test procedure for field strength measurements

7.5.2.1 The EUT was set up as shown in Figure 7.5.1, energized and its proper operation was checked.

7.5.2.2 The EUT was adjusted to produce maximum available to end user RF output power.

7.5.2.3 The field strength of the EUT carrier frequency was measured with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna height was swept in both vertical and horizontal polarizations.

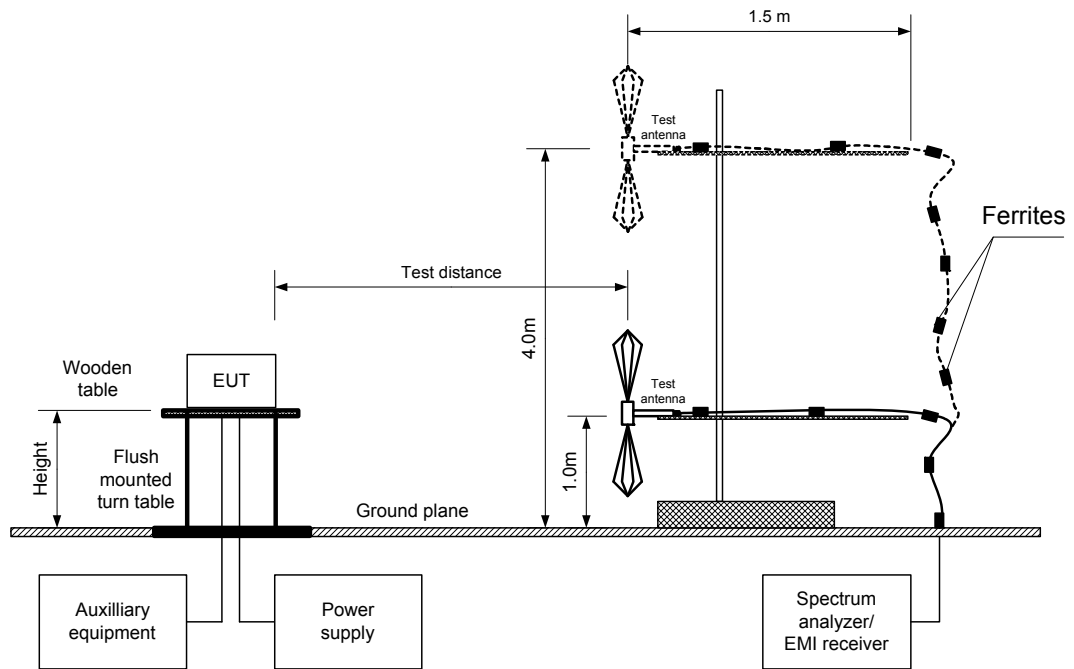
7.5.2.4 The maximum power spectral density was measured using a peak detector with resolution bandwidth set to 100 kHz, VBW≥300 kHz, sweep time = auto couple, trace mode=max hold.

7.5.2.5 The maximum power level was determined in any 100 kHz band within the fundamental EBW. The measured value exceeded the limit, the measurements were repeated with resolution bandwidth set to 30 kHz, VBW=100 kHz.

7.5.2.6 The test results provided in Table 7.5.2 and the associated plots.

|                     |                         |                                                   |                |
|---------------------|-------------------------|---------------------------------------------------|----------------|
| Test specification: |                         | Section 15.247(d), Maximum power spectral density |                |
| Test procedure:     |                         | ANSI C63.10 section 11.10.2                       |                |
| Test mode:          |                         | Verdict: PASS                                     |                |
| Date(s):            |                         |                                                   |                |
| 03-Apr-17           |                         |                                                   |                |
| Temperature: 23 °C  | Relative Humidity: 45 % | Air Pressure: 1010 hPa                            | Power: Battery |
| Remarks:            |                         |                                                   |                |

Figure 7.5.1 Setup for carrier field strength measurements





|                                                                              |                                |                               |                       |
|------------------------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.247(d), Maximum power spectral density |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.10 section 11.10.2                           |                                |                               |                       |
| <b>Test mode:</b> Compliance                                                 |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 03-Apr-17                                                    |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                                    | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                                              |                                |                               |                       |

Table 7.5.2 Field strength measurement of peak spectral power density

ASSIGNED FREQUENCY: 2400-2483.5 MHz  
 TEST DISTANCE: 3 m  
 TEST SITE: OATS  
 EUT HEIGHT: 1.5 m  
 DETECTOR USED: Peak  
 RESOLUTION BANDWIDTH: 10 kHz  
 VIDEO BANDWIDTH: 30 kHz  
 TEST ANTENNA TYPE: Double ridged guide (above 1000 MHz)  
 MODULATION: BLE (GFSK)  
 BIT RATE: 1 Mbps

| Frequency, MHz | Field strength, dB(μV/m) | EUT antenna gain, dBi | Limit, dB(μV/m) | Margin, dB* | Antenna polarization | Antenna height, m | Turn-table position**, degrees |
|----------------|--------------------------|-----------------------|-----------------|-------------|----------------------|-------------------|--------------------------------|
| 2402           | 94.71                    | 1                     | 103.2           | -9.49       | Horizontal           | 1.6               | 208                            |
| 2440           | 94.02                    | 1                     | 103.2           | -10.18      | Horizontal           | 1.5               | 215                            |
| 2480           | 95.23                    | 1                     | 103.2           | -8.97       | Horizontal           | 1.5               | 215                            |

\*- Margin = Field strength - EUT antenna gain - calculated field strength limit.

\*\* - EUT front panel refer to 0 degrees position of turntable.

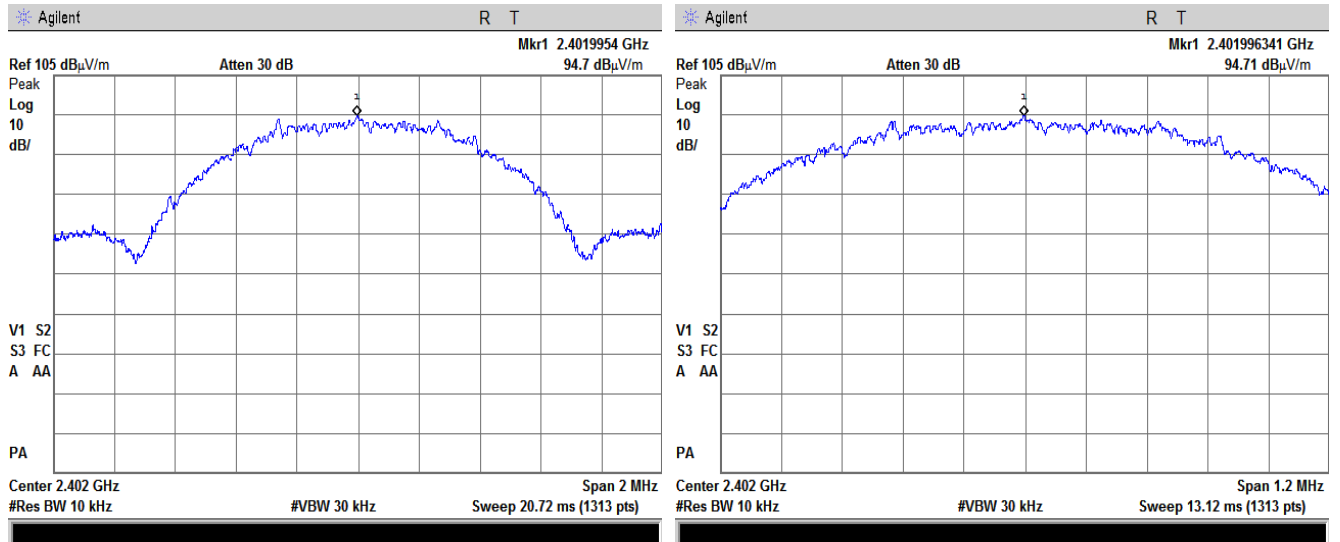
## Reference numbers of test equipment used

|         |         |         |  |  |  |  |  |
|---------|---------|---------|--|--|--|--|--|
| HL 2909 | HL 4114 | HL 5103 |  |  |  |  |  |
|---------|---------|---------|--|--|--|--|--|

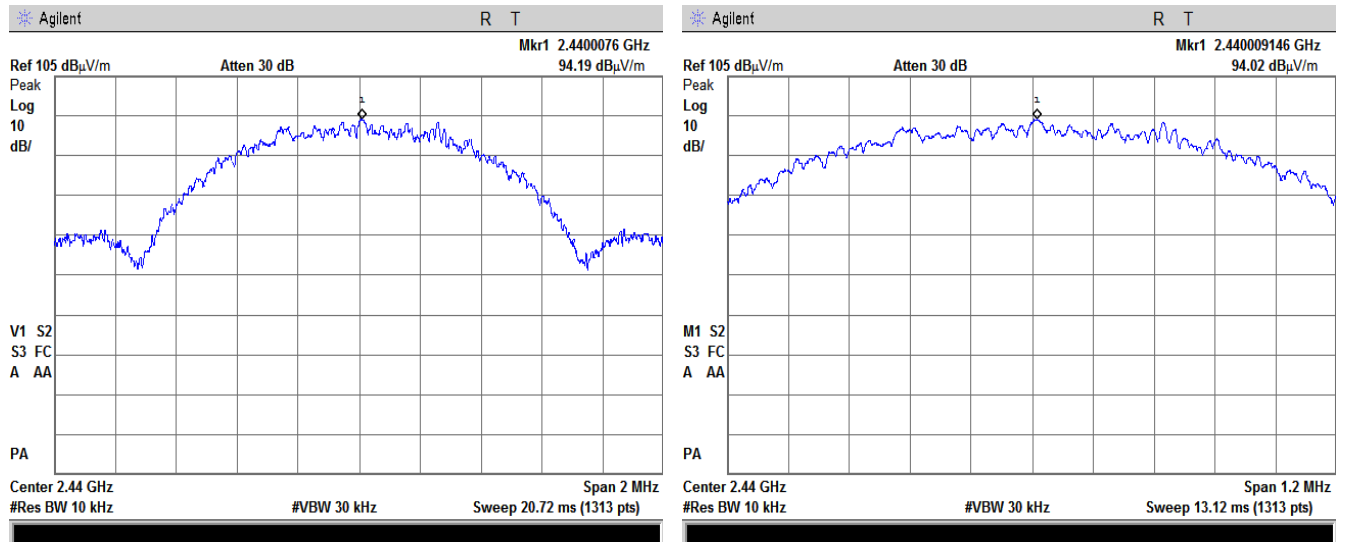
Full description is given in Appendix A.

|                     |                         |                                                   |                |
|---------------------|-------------------------|---------------------------------------------------|----------------|
| Test specification: |                         | Section 15.247(d), Maximum power spectral density |                |
| Test procedure:     |                         | ANSI C63.10 section 11.10.2                       |                |
| Test mode:          |                         | Verdict: PASS                                     |                |
| Date(s):            |                         |                                                   |                |
| 03-Apr-17           |                         |                                                   |                |
| Temperature: 23 °C  | Relative Humidity: 45 % | Air Pressure: 1010 hPa                            | Power: Battery |
| Remarks:            |                         |                                                   |                |

Plot 7.5.1 Peak spectral power density at low frequency



Plot 7.5.2 Peak spectral power density at mid frequency

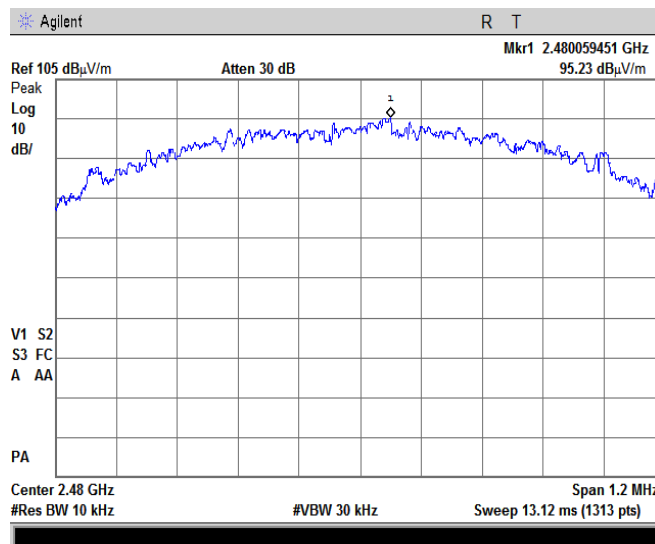
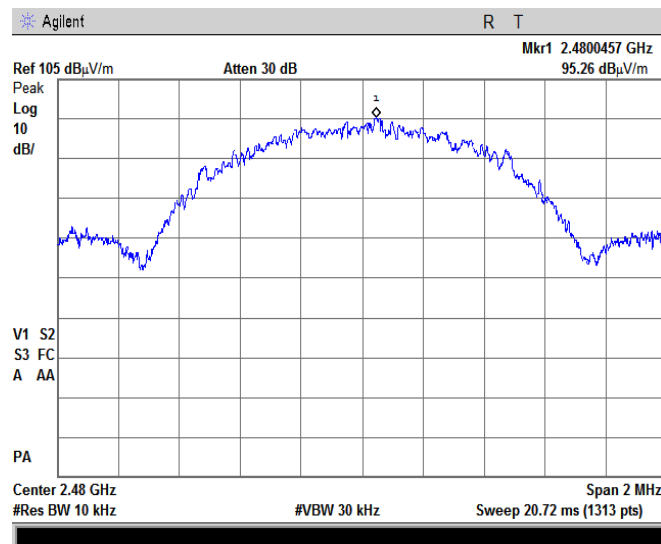




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|                                                                       |                         |                        |                |
|-----------------------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.247(d), Maximum power spectral density |                         |                        |                |
| Test procedure: ANSI C63.10 section 11.10.2                           |                         |                        |                |
| Test mode: Compliance                                                 |                         | Verdict: PASS          |                |
| Date(s): 03-Apr-17                                                    |                         |                        |                |
| Temperature: 23 °C                                                    | Relative Humidity: 45 % | Air Pressure: 1010 hPa | Power: Battery |
| Remarks:                                                              |                         |                        |                |

Plot 7.5.3 Peak spectral power density at high frequency





|                            |                                |                                             |                       |
|----------------------------|--------------------------------|---------------------------------------------|-----------------------|
| <b>Test specification:</b> |                                | <b>Section 15.203, Antenna requirements</b> |                       |
| <b>Test procedure:</b>     |                                | Visual inspection                           |                       |
| <b>Test mode:</b>          |                                | Compliance                                  | <b>Verdict:</b> PASS  |
| <b>Date(s):</b>            |                                | 04-Apr-17                                   |                       |
| <b>Temperature:</b> 23 °C  | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa               | <b>Power:</b> Battery |
| <b>Remarks:</b>            |                                |                                             |                       |

## 7.6 Antenna requirements

The EUT was verified for compliance with antenna requirements. A transmitter shall be designed to ensure that no antenna other than that furnished by the responsible party will be used with the device. It may be either permanently attached or employs a unique antenna connector for every antenna proposed for use with the EUT. This requirement does not apply to professionally installed transmitters.

The rationale for compliance with the above requirements was either visual inspection results or supplier declaration. The summary of results is provided in Table 7.6.1.

**Table 7.6.1 Antenna requirements**

| Requirement                                        | Rationale         | Verdict |
|----------------------------------------------------|-------------------|---------|
| The transmitter antenna is permanently attached    | Visual inspection | Comply  |
| The transmitter employs a unique antenna connector | NA                |         |
| The transmitter requires professional installation | NA                |         |



|                                                              |                                |                               |                       |
|--------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.109, Radiated emission |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.4, Sections 8.3 and 12.2.5   |                                |                               |                       |
| <b>Test mode:</b> Compliance                                 |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 04-Apr-17                                    |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                    | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                              |                                |                               |                       |

## 8 Unintentional emissions

### 8.1 Radiated emission measurements

#### 8.1.1 General

This test was performed to measure radiated emissions from the EUT enclosure. Specification test limits are given in Table 8.1.1.

Table 8.1.1 Radiated emission test limits

| Frequency,<br>MHz | Class B limit, dB(μV/m) |              | Class A limit, dB(μV/m) |              |
|-------------------|-------------------------|--------------|-------------------------|--------------|
|                   | 10 m distance           | 3 m distance | 10 m distance           | 3 m distance |
| 30 - 88           | 29.5*                   | 40.0         | 39.0                    | 49.5*        |
| 88 - 216          | 33.0*                   | 43.5         | 43.5                    | 54.0*        |
| 216 - 960         | 35.5*                   | 46.0         | 46.4                    | 56.9*        |
| Above 960         | 43.5*                   | 54.0         | 49.5                    | 60.0*        |

\* The limit for test distance other than specified was calculated using the inverse linear distance extrapolation factor as follows:  $\text{Lim}_{S2} = \text{Lim}_{S1} + 20 \log(S_1/S_2)$ , where  $S_1$  and  $S_2$  – standard defined and test distance respectively in meters.

#### 8.1.2 Test procedure

8.1.2.1 The EUT was set up as shown in Figure 8.1.1 and associated photograph/s, energized and the performance check was conducted.

8.1.2.2 Preliminary measurements were performed in the anechoic chamber at 3 m test distance. The specified frequency range was investigated with biconical and log periodic antennas connected to EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed, its polarization was switched from vertical to horizontal and the EUT cables position was varied.

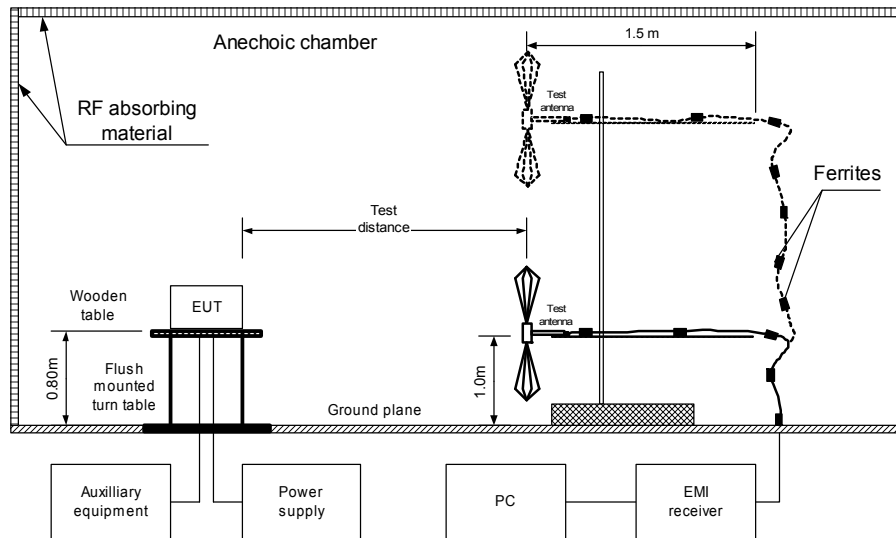
8.1.2.3 The EUT was set up as shown in Figure 8.1.2, energized and the performance check was conducted.

8.1.2.4 Final measurements were performed at the open area test site at 3 m test distance. The EUT wires and cables were arranged to produce maximum emission as it was found during preliminary measurements. The frequencies yield the worst test results (the lowest margins) during preliminary testing were investigated with biconilog antenna connected to EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m and its polarization was changed from vertical to horizontal.

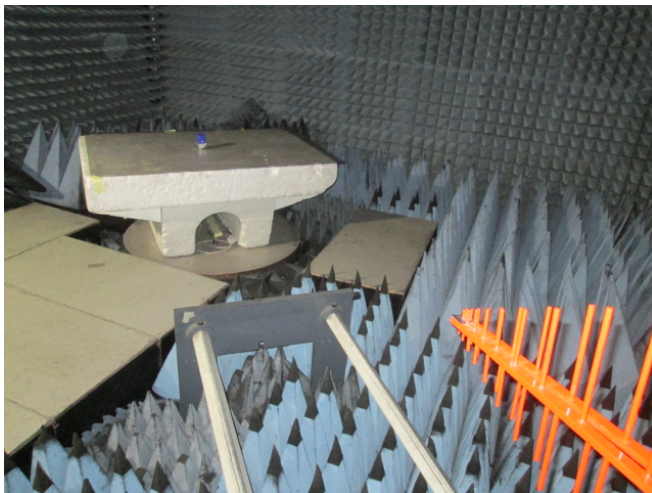
8.1.2.5 The worst test results (the lowest margins) were recorded in Table 8.1.2 and shown in the associated plots.

|                                                              |                                |                               |                       |
|--------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.109, Radiated emission |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.4, Sections 8.3 and 12.2.5   |                                |                               |                       |
| <b>Test mode:</b> Compliance                                 |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 04-Apr-17                                    |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                    | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                              |                                |                               |                       |

Figure 8.1.1 Setup for radiated emission measurements in anechoic chamber, table-top equipment

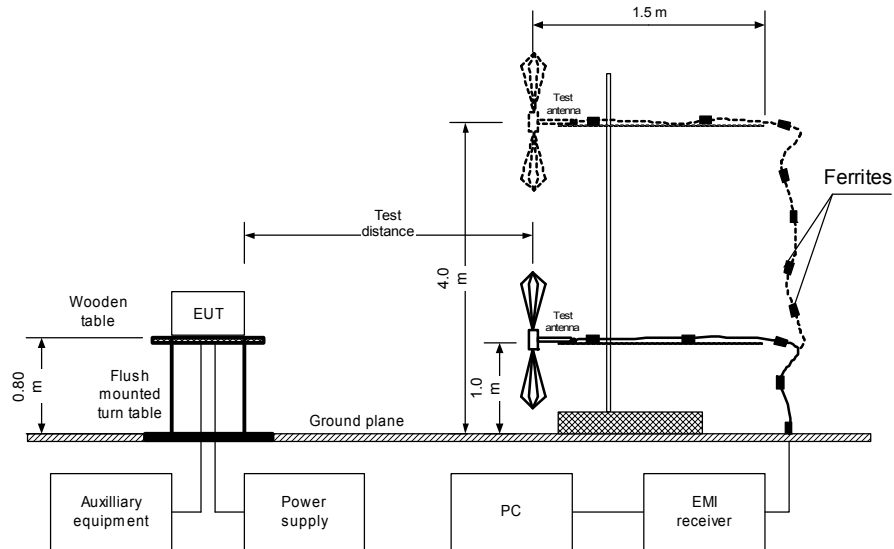


Photograph 8.1.1 Setup for radiated emission measurements



|                     |                         |                                     |                |
|---------------------|-------------------------|-------------------------------------|----------------|
| Test specification: |                         | Section 15.109, Radiated emission   |                |
| Test procedure:     |                         | ANSI C63.4, Sections 8.3 and 12.2.5 |                |
| Test mode:          |                         | Verdict: PASS                       |                |
| Date(s):            |                         |                                     |                |
| 04-Apr-17           |                         |                                     |                |
| Temperature: 23 °C  | Relative Humidity: 45 % | Air Pressure: 1010 hPa              | Power: Battery |
| Remarks:            |                         |                                     |                |

Figure 8.1.2 Setup for radiated emission measurements at OATS, table-top equipment



Photograph 8.1.2 Setup for radiated emission measurements





|                                                              |                                |                               |                       |
|--------------------------------------------------------------|--------------------------------|-------------------------------|-----------------------|
| <b>Test specification:</b> Section 15.109, Radiated emission |                                |                               |                       |
| <b>Test procedure:</b> ANSI C63.4, Sections 8.3 and 12.2.5   |                                |                               |                       |
| <b>Test mode:</b> Compliance                                 |                                | <b>Verdict:</b> PASS          |                       |
| <b>Date(s):</b> 04-Apr-17                                    |                                |                               |                       |
| <b>Temperature:</b> 23 °C                                    | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa | <b>Power:</b> Battery |
| <b>Remarks:</b>                                              |                                |                               |                       |

Table 8.1.2 Radiated emission test results

EUT SET UP: TABLE-TOP  
LIMIT: Class B  
EUT OPERATING MODE: Receive  
TEST SITE: Anechoic chamber  
TEST DISTANCE: 3 m  
DETECTORS USED: PEAK / QUASI-PEAK  
FREQUENCY RANGE: 30 MHz – 1000 MHz  
RESOLUTION BANDWIDTH: 120 kHz

| Frequency, MHz          |                             | Quasi-peak      |             |  | Antenna polarization | Antenna height, m | Turn-table position**, degrees | Verdict |
|-------------------------|-----------------------------|-----------------|-------------|--|----------------------|-------------------|--------------------------------|---------|
| Peak emission, dB(μV/m) | Measured emission, dB(μV/m) | Limit, dB(μV/m) | Margin, dB* |  |                      |                   |                                |         |
| No signals were found   |                             |                 |             |  |                      |                   |                                | Pass    |

TEST SITE: OATS  
TEST DISTANCE: 3 m  
DETECTORS USED: PEAK / AVERAGE  
FREQUENCY RANGE: 1000 MHz – 12500 MHz  
RESOLUTION BANDWIDTH: 1000 kHz

| Frequency,<br>MHz | Peak                              |                    |                | Average                           |                    |                | Antenna<br>polarization | Antenna<br>height,<br>m | Turn-table<br>position**,<br>degrees | Verdict |
|-------------------|-----------------------------------|--------------------|----------------|-----------------------------------|--------------------|----------------|-------------------------|-------------------------|--------------------------------------|---------|
|                   | Measured<br>emission,<br>dB(μV/m) | Limit,<br>dB(μV/m) | Margin,<br>dB* | Measured<br>emission,<br>dB(μV/m) | Limit,<br>dB(μV/m) | Margin,<br>dB* |                         |                         |                                      |         |
| 4962.5            | 44.6                              | 74                 | -29.4          | 41.1                              | 54                 | -12.9          | Horizontal              | 1.3                     | 200                                  | Pass    |

\*- Margin = Measured emission - specification limit.

\*\*-. EUT front panel refer to 0 degrees position of turntable.

## Reference numbers of test equipment used

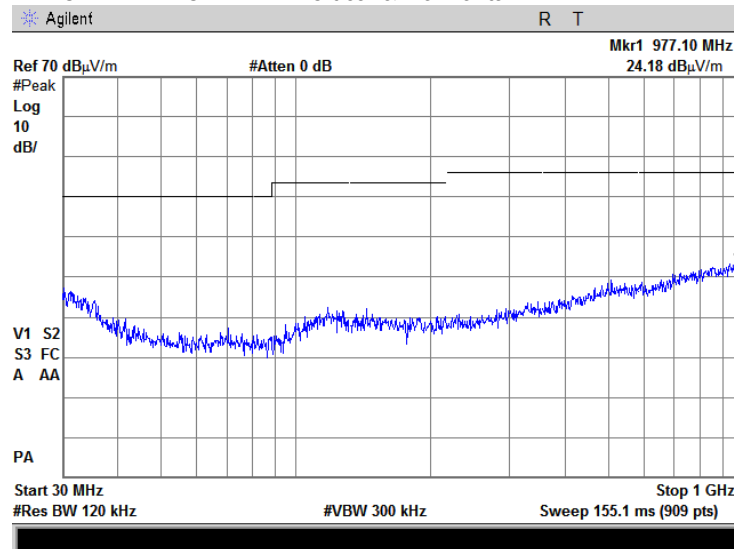
|         |         |         |         |         |         |  |  |
|---------|---------|---------|---------|---------|---------|--|--|
| HL 2697 | HL 2780 | HL 4114 | HL 5103 | HL 5107 | HL 5110 |  |  |
|---------|---------|---------|---------|---------|---------|--|--|

Full description is given in Appendix A.

|                            |                                |                                          |                       |
|----------------------------|--------------------------------|------------------------------------------|-----------------------|
| <b>Test specification:</b> |                                | <b>Section 15.109, Radiated emission</b> |                       |
| <b>Test procedure:</b>     |                                | ANSI C63.4, Sections 8.3 and 12.2.5      |                       |
| <b>Test mode:</b>          |                                | Compliance                               | <b>Verdict:</b> PASS  |
| <b>Date(s):</b>            |                                | 04-Apr-17                                |                       |
| <b>Temperature:</b> 23 °C  | <b>Relative Humidity:</b> 45 % | <b>Air Pressure:</b> 1010 hPa            | <b>Power:</b> Battery |
| <b>Remarks:</b>            |                                |                                          |                       |

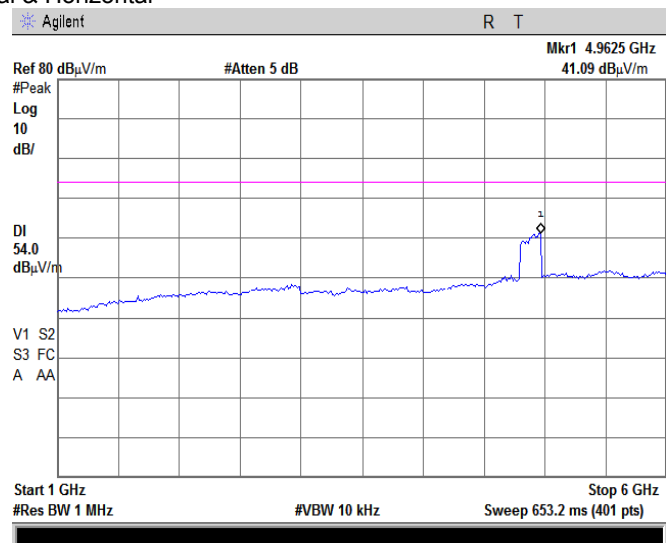
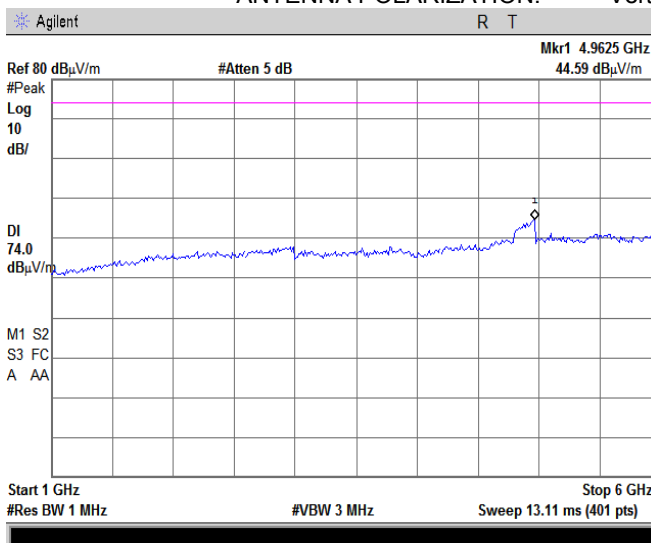
**Plot 8.1.1 Radiated emission measurements in 30 - 1000 MHz range**

TEST SITE: Anechoic chamber  
LIMIT: Class B  
TEST DISTANCE: 3 m  
EUT OPERATING MODE: Receive  
ANTENNA POLARIZATION: Vertical & Horizontal



**Plot 8.1.2 Radiated emission measurements in 1000 - 6000 MHz range**

TEST SITE: Anechoic chamber  
LIMIT: Class B  
TEST DISTANCE: 3 m  
EUT OPERATING MODE: Receive  
ANTENNA POLARIZATION: Vertical & Horizontal



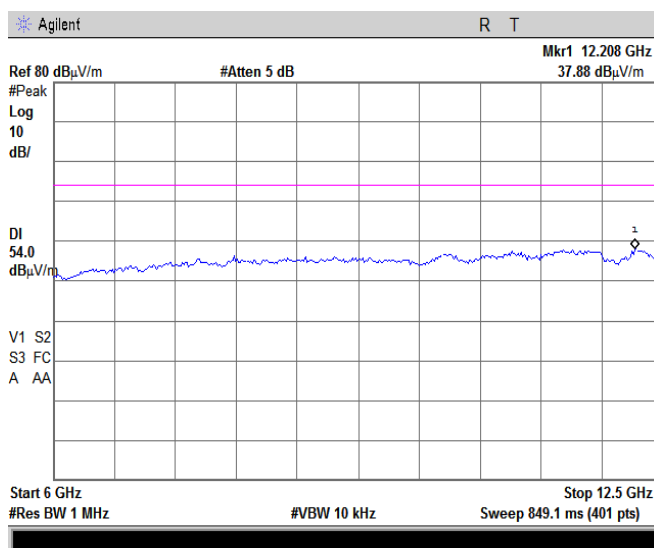
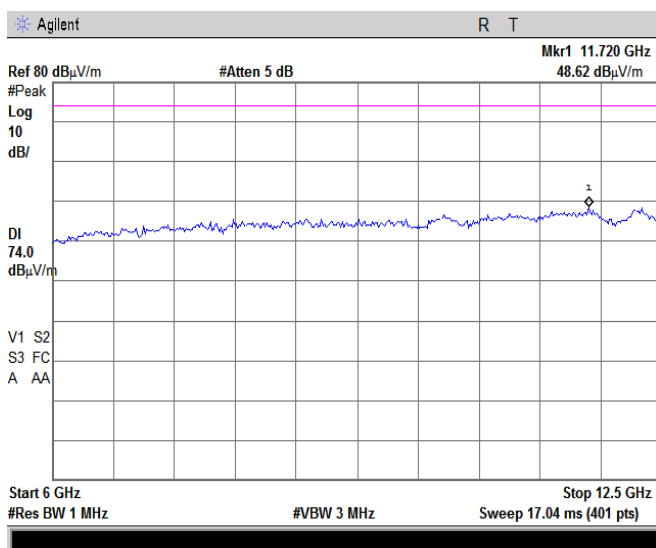


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|                                                       |                         |                        |                |
|-------------------------------------------------------|-------------------------|------------------------|----------------|
| Test specification: Section 15.109, Radiated emission |                         |                        |                |
| Test procedure: ANSI C63.4, Sections 8.3 and 12.2.5   |                         |                        |                |
| Test mode: Compliance                                 |                         | Verdict: PASS          |                |
| Date(s): 04-Apr-17                                    |                         |                        |                |
| Temperature: 23 °C                                    | Relative Humidity: 45 % | Air Pressure: 1010 hPa | Power: Battery |
| Remarks:                                              |                         |                        |                |

Plot 8.1.3 Radiated emission measurements in 6000 - 12500 MHz range

TEST SITE: Anechoic chamber  
LIMIT: Class B  
TEST DISTANCE: 3 m  
EUT OPERATING MODE: Receive  
ANTENNA POLARIZATION: Vertical & Horizontal



## 9 APPENDIX A Test equipment and ancillaries used for tests

| HL No | Description                                                                 | Manufacturer                                     | Model                       | Ser. No.    | Last Cal./ Check | Due Cal./ Check |
|-------|-----------------------------------------------------------------------------|--------------------------------------------------|-----------------------------|-------------|------------------|-----------------|
| 0446  | Antenna, Loop, Active, 10 kHz - 30 MHz                                      | EMCO                                             | 6502                        | 2857        | 19-Jan-17        | 19-Jan-18       |
| 2432  | Antenna, Double-Ridged Waveguide Horn 1 to 18 GHz                           | EMC Test Systems                                 | 3115                        | 00027177    | 07-Feb-17        | 07-Feb-18       |
| 2697  | Antenna, 30 MHz - 3.0 GHz                                                   | Sunol Sciences. Corp. Pleasanton, California USA | JB3                         | A022805     | 10-May-16        | 10-May-17       |
| 2780  | EMC analyzer, 100 Hz to 26.5 GHz                                            | Agilent Technologies                             | E7405A                      | MY451024 62 | 21-Feb-17        | 21-Feb-18       |
| 2909  | Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz                                | Agilent Technologies                             | E4407B                      | MY414447 62 | 09-Mar-17        | 09-Mar-18       |
| 3818  | PSA Series Spectrum Analyzer, 3 Hz- 44 GHz                                  | Agilent Technologies                             | E4446A                      | MY482502 88 | 03-May-16        | 03-May-17       |
| 4114  | Antenna, Double-Ridged Waveguide Horn, 1 to 18 GHz                          | ETS Lindgren                                     | 3117                        | 00123515    | 17-Jan-17        | 17-Jan-18       |
| 4338  | Reject Band Filter, 50 Ohm, 0 to 2170 and 3000 to 18000 MHz, SMA-FM / SMA-M | Micro-Tronics                                    | BRM 50702-02                | 023         | 08-May-16        | 08-May-17       |
| 4933  | Active Horn Antenna, 1 GHz to 18 GHz                                        | Com-Power Corporation                            | AHA-118                     | 701046      | 14-Oct-16        | 14-Oct-17       |
| 4956  | Active horn antenna, 18 to 40 GHz                                           | Com-Power Corporation                            | AHA-840                     | 105004      | 17-Jan-17        | 17-Jan-18       |
| 5103  | RF cable, 18 GHz, 6 m, N-type                                               | Huber-Suhner                                     | SF106A/1 1N/11N/6 000MM     | 500849/6A   | 26-Jul-16        | 26-Jul-17       |
| 5107  | RF cable, 18 GHz, 4.5 m, N-type                                             | Huber-Suhner                                     | SF106A/1 1N/11N/4 500MM     | 500845/6A   | 26-Jul-16        | 26-Jul-17       |
| 5110  | RF cable, 18 GHz, 3 m, N-type                                               | Huber-Suhner                                     | ST18A/N m/Nm/300 0          | 600818/18 A | 26-Jul-16        | 26-Jul-17       |
| 5112  | RF cable, 40 GHz, 5.5 m, K-type                                             | Huber-Suhner                                     | SF102EA/ 11SK/11S K/5500M M | 502494/2E A | 26-Jul-16        | 26-Jul-17       |

## 10 APPENDIX B Measurement uncertainties

### Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

| Test description                                                                                     | Expanded uncertainty                                                                                                                                                                                                                                                                                         |
|------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Conducted carrier power at RF antenna connector                                                      | Below 12.4 GHz: $\pm 1.7$ dB<br>12.4 GHz to 40 GHz: $\pm 2.3$ dB                                                                                                                                                                                                                                             |
| Conducted emissions at RF antenna connector                                                          | 9 kHz to 2.9 GHz: $\pm 2.6$ dB<br>2.9 GHz to 6.46 GHz: $\pm 3.5$ dB<br>6.46 GHz to 13.2 GHz: $\pm 4.3$ dB<br>13.2 GHz to 22.0 GHz: $\pm 5.0$ dB<br>22.0 GHz to 26.8 GHz: $\pm 5.5$ dB<br>26.8 GHz to 40.0 GHz: $\pm 4.8$ dB                                                                                  |
| Occupied bandwidth                                                                                   | $\pm 8.0$ %                                                                                                                                                                                                                                                                                                  |
| Duty cycle, timing (Tx ON / OFF) and average factor measurements                                     | $\pm 1.0$ %                                                                                                                                                                                                                                                                                                  |
| Conducted emissions with LISN                                                                        | 9 kHz to 150 kHz: $\pm 3.9$ dB<br>150 kHz to 30 MHz: $\pm 3.8$ dB                                                                                                                                                                                                                                            |
| Radiated emissions at 3 m measuring distance<br>Horizontal polarization<br><br>Vertical polarization | Biconilog antenna: $\pm 5.3$ dB<br>Biconical antenna: $\pm 5.0$ dB<br>Log periodic antenna: $\pm 5.3$ dB<br>Double ridged horn antenna: $\pm 5.3$ dB<br>Biconilog antenna: $\pm 6.0$ dB<br>Biconical antenna: $\pm 5.7$ dB<br>Log periodic antenna: $\pm 6.0$ dB<br>Double ridged horn antenna: $\pm 6.0$ dB |

Hermon Laboratories is accredited by A2LA for calibration according to present requirements of ISO/IEC 17025 and NCSL Z540-1. The accreditation is granted to perform calibration of parameters that are listed in the Scope of Hermon Laboratories Accreditation.

Hermon Laboratories calibrates its reference and transfer standards by calibration laboratories accredited to ISO/IEC 17025 by a mutually recognized Accreditation Body or by a recognized national metrology institute. All reference and transfer standards used in the calibration system are traceable to national or international standards.

In-house calibration of all test and measurement equipment is performed on a regular basis according to Hermon Laboratories calibration procedures, manufacturer calibration/verification procedures or procedures defined in the relevant standards. The Hermon Laboratories test and measurement equipment is calibrated within the tolerances specified by the manufacturers and/or by the relevant standards.

## 11 APPENDIX C Test laboratory description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private, EMC, Radio, Safety, Environmental and Telecommunication testing facility.

Hermon Laboratories is recognized and accredited by the Federal Communications Commission (USA) for 1, 2, 15, 18 parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; registered by Industry Canada for electromagnetic emissions, file number IC 2186A-1 for OATS, certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-1082 for anechoic chamber, G-869 for RE measurements above 1 GHz, C-845 for conducted emissions site and T-1606 for conducted emissions at telecommunication ports).

The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for electromagnetic compatibility, product safety, telecommunications testing, environmental simulation and calibration (for exact scope please refer to Certificate No. 839.01, 839.03 and 839.04).

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## 12 APPENDIX D Specification references

|                         |                                                                                                                                                                     |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FCC 47CFR part 15: 2016 | Radio Frequency Devices                                                                                                                                             |
| ANSI C63.10: 2013       | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices                                                                      |
| ANSI C63.2: 1996        | American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications                                            |
| ANSI C63.4: 2014        | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |

## 13 APPENDIX E Test equipment correction factors

Antenna factor  
Active loop antenna  
Model 6502, S/N 2857, HL 0446

| Frequency,<br>MHz | Magnetic antenna factor,<br>dB | Electric antenna factor,<br>dB |
|-------------------|--------------------------------|--------------------------------|
| 0.009             | -32.8                          | 18.7                           |
| 0.010             | -33.8                          | 17.7                           |
| 0.020             | -38.3                          | 13.2                           |
| 0.050             | -41.1                          | 10.4                           |
| 0.075             | -41.3                          | 10.2                           |
| 0.100             | -41.6                          | 9.9                            |
| 0.150             | -41.7                          | 9.8                            |
| 0.250             | -41.6                          | 9.9                            |
| 0.500             | -41.8                          | 9.8                            |
| 0.750             | -41.9                          | 9.7                            |
| 1.000             | -41.4                          | 10.1                           |
| 2.000             | -41.5                          | 10.0                           |
| 3.000             | -41.4                          | 10.2                           |
| 4.000             | -41.4                          | 10.1                           |
| 5.000             | -41.5                          | 10.1                           |
| 10.000            | -41.9                          | 9.6                            |
| 15.000            | -41.9                          | 9.6                            |
| 20.000            | -42.2                          | 9.3                            |
| 25.000            | -42.8                          | 8.7                            |
| 30.000            | -44.0                          | 7.5                            |

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB( $\mu$ V) to convert it into field strength in dB( $\mu$ V/m).

**Antenna factor**  
**Double-ridged guide horn antenna**  
**Model 3115, serial number: 00027177, HL 2432**

| Frequency,<br>MHz | Antenna factor.<br>dB(1/m) |
|-------------------|----------------------------|
| 1000.0            | 24.7                       |
| 1500.0            | 25.7                       |
| 2000.0            | 27.8                       |
| 2500.0            | 28.9                       |
| 3000.0            | 30.7                       |
| 3500.0            | 31.8                       |
| 4000.0            | 33.0                       |
| 4500.0            | 32.8                       |
| 5000.0            | 34.2                       |
| 5500.0            | 34.9                       |
| 6000.0            | 35.2                       |
| 6500.0            | 35.4                       |
| 7000.0            | 36.3                       |
| 7500.0            | 37.3                       |
| 8000.0            | 37.5                       |
| 8500.0            | 38.0                       |
| 9000.0            | 38.3                       |
| 9500.0            | 38.3                       |
| 10000.0           | 38.7                       |
| 10500.0           | 38.7                       |
| 11000.0           | 38.9                       |
| 11500.0           | 39.5                       |
| 12000.0           | 39.5                       |
| 12500.0           | 39.4                       |
| 13000.0           | 40.5                       |
| 13500.0           | 40.8                       |
| 14000.0           | 41.5                       |
| 14500.0           | 41.3                       |
| 15000.0           | 40.2                       |
| 15500.0           | 38.7                       |
| 16000.0           | 38.5                       |
| 16500.0           | 39.8                       |
| 17000.0           | 41.9                       |
| 17500.0           | 45.8                       |
| 18000.0           | 49.1                       |

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB( $\mu$ V) to convert it into field strength in dB( $\mu$ V/m).

Antenna calibration  
Sunol Sciences Inc., model JB3, serial number A022805, HL 2697

| Frequency, MHz | ACF, dB | Gain, dBi | Num gain | Frequency, MHz | ACF, dB | Gain, dBi | Num gain | Frequency, MHz | ACF, dB | Gain, dBi | Num gain | Frequency, MHz | ACF, dB | Gain, dBi | Num gain | Frequency, MHz | ACF, dB | Gain, dBi | Num gain |
|----------------|---------|-----------|----------|----------------|---------|-----------|----------|----------------|---------|-----------|----------|----------------|---------|-----------|----------|----------------|---------|-----------|----------|
| 30             | 22.2    | -22.5     | 0.01     | 620            | 19.7    | 6.3       | 4.27     | 1215           | 24.9    | 7.0       | 5.05     | 1810           | 28.3    | 7.1       | 5.08     | 2405           | 30.9    | 6.9       | 4.93     |
| 35             | 18.5    | -17.4     | 0.02     | 625            | 19.7    | 6.5       | 4.42     | 1220           | 24.9    | 7.0       | 4.99     | 1815           | 28.5    | 6.9       | 4.91     | 2410           | 30.9    | 6.9       | 4.89     |
| 40             | 14.7    | -12.5     | 0.06     | 630            | 19.6    | 6.6       | 4.57     | 1225           | 25.1    | 6.9       | 4.91     | 1820           | 28.6    | 6.8       | 4.74     | 2415           | 31.0    | 6.9       | 4.85     |
| 45             | 11.3    | -8.1      | 0.16     | 635            | 19.7    | 6.5       | 4.48     | 1230           | 25.2    | 6.8       | 4.82     | 1825           | 28.7    | 6.8       | 4.75     | 2420           | 31.0    | 6.8       | 4.82     |
| 45             | 11.3    | -8.1      | 0.16     | 640            | 19.9    | 6.4       | 4.40     | 1235           | 25.1    | 7.0       | 4.96     | 1830           | 28.7    | 6.8       | 4.76     | 2425           | 31.1    | 6.8       | 4.81     |
| 50             | 8.9     | -4.7      | 0.34     | 645            | 19.9    | 6.5       | 4.45     | 1240           | 25.0    | 7.1       | 5.09     | 1835           | 28.7    | 6.7       | 4.72     | 2430           | 31.0    | 6.9       | 4.87     |
| 55             | 7.9     | -2.8      | 0.52     | 650            | 19.9    | 6.5       | 4.51     | 1245           | 25.0    | 7.1       | 5.12     | 1840           | 28.8    | 6.7       | 4.69     | 2435           | 31.0    | 6.9       | 4.86     |
| 60             | 7.5     | -2.1      | 0.62     | 655            | 19.9    | 6.6       | 4.60     | 1250           | 25.0    | 7.1       | 5.15     | 1845           | 28.6    | 6.9       | 4.90     | 2440           | 31.2    | 6.8       | 4.74     |
| 65             | 8.5     | -2.0      | 0.63     | 660            | 19.9    | 6.7       | 4.69     | 1255           | 25.0    | 7.2       | 5.25     | 1850           | 28.4    | 7.1       | 5.12     | 2445           | 31.1    | 6.9       | 4.91     |
| 70             | 9.0     | -1.9      | 0.64     | 665            | 19.9    | 6.7       | 4.70     | 1260           | 24.9    | 7.3       | 5.36     | 1855           | 28.5    | 7.0       | 5.07     | 2450           | 31.0    | 7.0       | 4.96     |
| 75             | 8.8     | -1.1      | 0.78     | 670            | 20.0    | 6.7       | 4.71     | 1265           | 25.0    | 7.3       | 5.31     | 1860           | 28.6    | 7.0       | 5.01     | 2455           | 31.0    | 7.0       | 5.01     |
| 80             | 8.4     | -0.2      | 0.97     | 675            | 20.1    | 6.7       | 4.71     | 1270           | 25.1    | 7.2       | 5.26     | 1865           | 28.5    | 7.1       | 5.17     | 2460           | 30.9    | 7.2       | 5.19     |
| 85             | 8.0     | 0.6       | 1.20     | 680            | 20.1    | 6.7       | 4.71     | 1275           | 25.3    | 7.0       | 5.05     | 1870           | 28.4    | 7.3       | 5.33     | 2465           | 31.1    | 6.9       | 4.95     |
| 90             | 8.2     | 1.1       | 1.29     | 685            | 20.1    | 6.8       | 4.79     | 1280           | 25.5    | 6.8       | 4.94     | 1875           | 28.4    | 7.2       | 5.28     | 2470           | 31.3    | 6.8       | 4.76     |
| 95             | 9.2     | 0.5       | 1.13     | 690            | 20.1    | 6.9       | 4.88     | 1285           | 25.4    | 7.0       | 4.97     | 1880           | 28.5    | 7.2       | 5.22     | 2475           | 31.4    | 6.7       | 4.69     |
| 100            | 10.6    | -0.4      | 0.92     | 695            | 20.2    | 6.8       | 4.82     | 1290           | 25.3    | 7.1       | 5.10     | 1885           | 28.5    | 7.2       | 5.22     | 2480           | 31.3    | 6.8       | 4.79     |
| 110            | 12.6    | -1.6      | 0.70     | 705            | 20.4    | 6.8       | 4.75     | 1300           | 25.2    | 7.3       | 5.33     | 1895           | 28.6    | 7.2       | 5.24     | 2490           | 31.1    | 7.0       | 4.99     |
| 120            | 13.9    | -2.1      | 0.62     | 715            | 20.5    | 6.8       | 4.80     | 1310           | 25.5    | 7.1       | 5.09     | 1905           | 28.5    | 7.3       | 5.36     | 2500           | 30.9    | 7.2       | 5.27     |
| 125            | 14.2    | -2.0      | 0.63     | 720            | 20.5    | 6.9       | 4.85     | 1315           | 25.4    | 7.2       | 5.23     | 1910           | 28.5    | 7.4       | 5.45     | 2505           | 31.1    | 7.1       | 5.15     |
| 130            | 14.2    | -1.7      | 0.68     | 725            | 20.6    | 6.8       | 4.81     | 1320           | 25.3    | 7.3       | 5.36     | 1915           | 28.5    | 7.3       | 5.38     | 2510           | 31.0    | 7.2       | 5.22     |
| 140            | 13.4    | 0.3       | 0.94     | 735            | 20.9    | 6.7       | 4.55     | 1330           | 25.6    | 7.0       | 5.06     | 1925           | 28.5    | 7.3       | 5.39     | 2520           | 31.2    | 7.0       | 5.05     |
| 150            | 12.9    | 0.8       | 1.21     | 745            | 21.0    | 6.6       | 4.59     | 1340           | 25.7    | 7.1       | 5.09     | 1935           | 28.5    | 7.4       | 5.54     | 2530           | 31.0    | 7.3       | 5.37     |
| 160            | 12.7    | 1.6       | 1.44     | 755            | 21.0    | 6.8       | 4.74     | 1350           | 25.7    | 7.1       | 5.17     | 1945           | 28.5    | 7.5       | 5.59     | 2540           | 31.2    | 7.1       | 5.09     |
| 165            | 12.5    | 2.0       | 1.59     | 760            | 21.0    | 6.8       | 4.83     | 1355           | 25.8    | 7.0       | 5.06     | 1950           | 28.6    | 7.4       | 5.48     | 2545           | 31.0    | 7.3       | 5.43     |
| 170            | 12.2    | 2.6       | 1.83     | 765            | 21.1    | 6.8       | 4.73     | 1360           | 25.9    | 6.9       | 4.95     | 1955           | 28.6    | 7.5       | 5.57     | 2550           | 31.0    | 7.3       | 5.39     |
| 175            | 11.8    | 3.3       | 2.13     | 770            | 21.3    | 6.7       | 4.64     | 1365           | 26.0    | 6.9       | 4.95     | 1960           | 28.6    | 7.5       | 5.65     | 2555           | 31.1    | 7.2       | 5.30     |
| 180            | 11.6    | 3.7       | 2.36     | 775            | 21.3    | 6.7       | 4.68     | 1370           | 26.0    | 7.0       | 4.98     | 1965           | 28.7    | 7.4       | 5.75     | 2560           | 31.0    | 7.4       | 5.47     |
| 185            | 11.5    | 4.0       | 2.54     | 780            | 21.3    | 6.7       | 4.72     | 1375           | 26.0    | 7.0       | 5.01     | 1970           | 28.5    | 7.2       | 5.29     | 2565           | 30.8    | 7.6       | 5.70     |
| 190            | 11.6    | 4.2       | 2.61     | 785            | 21.3    | 6.8       | 4.77     | 1380           | 26.0    | 7.0       | 5.06     | 1975           | 28.9    | 7.2       | 5.22     | 2570           | 31.1    | 7.3       | 5.37     |
| 200            | 13.1    | 3.2       | 2.07     | 795            | 21.4    | 6.8       | 4.79     | 1390           | 26.1    | 6.9       | 4.92     | 1985           | 29.1    | 7.1       | 5.11     | 2580           | 31.6    | 6.9       | 4.87     |
| 205            | 12.0    | 4.4       | 2.76     | 800            | 21.5    | 6.8       | 4.77     | 1395           | 26.2    | 6.9       | 4.94     | 1990           | 29.1    | 7.0       | 5.06     | 2585           | 31.6    | 6.8       | 4.79     |
| 210            | 11.0    | 5.6       | 3.66     | 805            | 21.6    | 6.7       | 4.71     | 1400           | 26.2    | 7.0       | 4.96     | 1995           | 29.1    | 7.1       | 5.09     | 2590           | 31.6    | 6.9       | 4.88     |
| 215            | 11.3    | 5.6       | 3.59     | 810            | 21.7    | 6.7       | 4.65     | 1405           | 26.1    | 7.0       | 5.02     | 2000           | 29.1    | 7.1       | 5.11     | 2595           | 31.5    | 7.0       | 4.97     |
| 220            | 11.6    | 5.5       | 3.52     | 815            | 21.7    | 6.7       | 4.72     | 1410           | 26.1    | 7.1       | 5.09     | 2005           | 29.1    | 7.1       | 5.16     | 2600           | 31.6    | 6.9       | 4.86     |
| 225            | 11.7    | 5.5       | 3.45     | 820            | 21.7    | 6.8       | 4.80     | 1415           | 26.2    | 7.0       | 5.02     | 2010           | 29.1    | 7.1       | 5.15     | 2605           | 31.3    | 7.2       | 5.30     |
| 230            | 11.9    | 5.5       | 3.57     | 825            | 21.7    | 6.8       | 4.82     | 1420           | 26.3    | 7.0       | 5.06     | 2015           | 29.2    | 7.1       | 5.13     | 2610           | 31.4    | 7.1       | 5.15     |
| 235            | 12.1    | 5.5       | 3.56     | 830            | 21.7    | 6.9       | 4.85     | 1425           | 26.2    | 7.1       | 5.10     | 2020           | 29.2    | 7.1       | 5.18     | 2615           | 31.7    | 6.9       | 4.88     |
| 240            | 12.3    | 5.5       | 3.54     | 835            | 21.8    | 6.8       | 4.82     | 1430           | 26.1    | 7.2       | 5.25     | 2025           | 29.3    | 7.1       | 5.08     | 2620           | 31.6    | 7.0       | 4.97     |
| 245            | 12.3    | 5.7       | 3.71     | 840            | 21.9    | 6.8       | 4.80     | 1435           | 26.1    | 7.2       | 5.24     | 2030           | 29.3    | 7.0       | 5.05     | 2625           | 31.4    | 7.1       | 5.17     |
| 250            | 12.3    | 5.9       | 3.88     | 845            | 21.9    | 6.8       | 4.83     | 1440           | 26.2    | 7.2       | 5.24     | 2035           | 29.3    | 7.1       | 5.07     | 2630           | 31.6    | 7.0       | 5.00     |
| 255            | 12.5    | 5.9       | 3.85     | 850            | 21.9    | 6.9       | 4.86     | 1445           | 26.3    | 1         | 5.11     | 2040           | 29.3    | 7.1       | 5.13     | 2635           | 31.8    | 6.8       | 4.82     |
| 260            | 12.7    | 5.8       | 3.83     | 855            | 22.0    | 6.8       | 4.80     | 1450           | 26.5    | 7.0       | 4.98     | 2045           | 29.2    | 7.2       | 5.23     | 2640           | 31.7    | 7.0       | 4.98     |
| 265            | 13.2    | 5.5       | 3.54     | 860            | 22.1    | 6.8       | 4.74     | 1455           | 26.4    | 7.1       | 5.07     | 2050           | 29.2    | 7.2       | 5.27     | 2645           | 31.7    | 6.9       | 4.93     |
| 270            | 13.7    | 5.2       | 3.27     | 865            | 22.1    | 6.9       | 4.82     | 1460           | 26.4    | 7.1       | 5.17     | 2055           | 29.3    | 7.2       | 5.21     | 2650           | 31.8    | 6.9       | 4.85     |
| 275            | 13.7    | 5.3       | 3.39     | 870            | 21.9    | 7.1       | 5.11     | 1465           | 26.4    | 7.2       | 5.19     | 2060           | 29.5    | 7.0       | 5.02     | 2655           | 31.8    | 6.9       | 4.85     |
| 280            | 13.7    | 5.4       | 3.50     | 875            | 22.0    | 7.1       | 5.08     | 1470           | 26.4    | 7.2       | 5.22     | 2065           | 29.4    | 7.1       | 5.08     | 2660           | 31.7    | 7.0       | 5.02     |
| 285            | 13.7    | 5.6       | 3.61     | 880            | 22.1    | 7.0       | 5.05     | 1475           | 26.4    | 7.1       | 5.17     | 2070           | 29.4    | 7.1       | 5.01     | 2665           | 32.0    | 6.7       | 4.71     |
| 290            | 13.7    | 5.7       | 3.72     | 885            | 22.1    | 7.0       | 5.06     | 1480           | 26.5    | 7.1       | 5.12     | 2075           | 29.5    | 7.0       | 5.01     | 2670           | 32.0    | 6.7       | 4.67     |
| 295            | 13.8    | 5.8       | 3.77     | 890            | 22.1    | 7.0       | 5.06     | 1485           | 26.5    | 7.1       | 5.14     | 2080           | 29.8    | 6.8       | 4.76     | 2675           | 31.9    | 6.8       | 4.81     |
| 300            | 13.9    | 5.8       | 3.81     | 895            | 22.2    | 7.1       | 5.09     | 1490           | 26.5    | 7.1       | 5.17     | 2085           | 29.7    | 6.9       | 4.89     | 2680           | 31.7    | 7.0       | 5.04     |
| 305            | 14.0    | 5.9       | 3.85     | 900            | 22.2    | 7.1       | 5.12     | 1495           | 26.5    | 7.2       | 5.24     | 2090           | 29.7    | 6.9       | 4.86     | 2685           | 31.9    | 6.8       | 4.83     |
| 310            | 14.1    | 5.9       | 3.88     | 905            | 22.3    | 7.1       | 5.09     | 1500           | 26.5    | 7.2       | 5.31     | 2095           | 29.8    | 6.8       | 4.78     | 2690           | 32.1    | 6.7       | 4.72     |
| 315            | 14.3    | 5.8       | 3.88     | 910            | 22.3    | 7.0       | 5.05     | 1505           | 26.5    | 7.2       | 5.27     | 2100           | 29.8    | 6.8       | 4.75     | 2695           | 32.1    | 6.7       | 4.71     |
| 320            | 14.4    | 5.9       | 3.90     | 915            | 22.4    | 7.0       | 4.99     | 1510           | 26.6    | 7.2       | 5.30     | 2105           | 29.8    | 6.8       | 4.81     | 2700           | 32.0    | 6.8       | 4.81     |
| 325            | 14.5    | 5.9       | 3.92     | 920            | 22.6    | 6.9       | 4.92     | 1515           | 26.6    | 7.2       | 5.32     | 2110           | 29.9    | 6.8       | 4.78     | 2705           | 32.0    | 6.8       | 4.80     |
| 330            | 14.6    | 5.9       | 3.93     | 925            | 22.7    | 6.9       | 4.85     | 1520           | 26.5    | 7.3       | 5.38     | 2115           | 29.9    | 6.8       | 4.76     | 2710           | 32.1    | 6.8       | 4.79     |
| 335            | 14.7    | 6.0       | 4.02     | 930            | 22.8    | 6.8       | 4.77     | 1525           | 26.6    | 7.3       | 5.37     | 2120           | 29.9    | 6.8       | 4.84     | 2715           | 32.1    | 6.7       | 4.71     |
| 340            | 14.7    | 6.2       | 4.12     | 935            | 22.8    | 6.8       | 4.83     | 1530           | 26.6    | 7.3       | 5.36     | 2125           | 29.9    | 6.9       | 4.89     | 2720           | 32.4    | 6.5       | 4.47     |
| 345            | 14.9    | 6.1       | 4.06     | 940            | 22.8    | 6.9       | 4.89     | 1535           | 26.6    | 7.4       | 5.44     | 2130           | 29.9    | 6.9       | 4.90     | 2725           | 32.2    | 6.7       | 4.63     |
| 350            | 15.1    | 6.0       | 3.99     | 945            | 22.8    | 6.9       | 4.87     | 1540           | 26.5    | 7.4       | 5.53     | 2135           | 29.8    | 6.9       | 4.94     | 2730           | 31.9    | 7.0       | 5.05     |
| 355            | 15.3    | 5.9       | 3.88     | 950            | 22.9    | 6.9       | 4.85     | 1545           | 26.5    | 7.5       | 5.58     | 2140           | 29.8    | 7.1       | 5.08     | 2735           | 31.6    | 7.4       | 5.44     |
| 360            | 15.8    | 5.6       | 3.78     | 955            | 23.0    | 6.8       | 4.81     | 1550           | 26.6    | 7.5       | 5.63     | 2145           | 29.8    | 6.9       | 4.92     | 2740           | 31.6    | 7.1       | 5.40     |
| 365            | 15.5    | 5.9       | 3.89     | 960            | 23.1    | 6.8       | 4.77     | 1555           | 26.7    | 7.3       | 5.59     | 2150           | 29.9    | 7.0       | 4.98     | 2745           | 31.9    | 7.0       | 5.06     |
| 370            | 15.5    | 6.0       | 4.01     | 965            | 23.1    | 6.7       | 4.73     | 1560           | 26.9    | 7.1       | 5.18     | 2155           | 29.8    | 7.1       | 5.10     | 2750           | 32.0    | 6.9       | 4.94     |
| 375            | 15.6    | 6.1       | 4.03     | 970            | 23.2    | 6.7       | 4.69     | 1565           | 26.9    | 7.2       | 5.23     | 2160           | 29.8    | 7.1       | 5.09     | 2755           | 32.0    | 7.0       | 5.08     |
| 380            | 15.7    | 6.1       | 4.05     | 975            | 23.3    | 6.6       | 4.62     | 1570           | 26.9    | 7.2       | 5.30     | 2165           | 29.9    | 7.0       | 5.00     | 2760           | 32.0    | 7.0       | 4.96     |
| 385            | 15.7    | 6.2       | 4.15     | 980            | 23.5    | 6.6       | 4.54     | 1575           | 27.0    | 7.2       | 5.23     | 2170           | 29.9    | 7.1       | 5.07     | 2765           | 32.2    | 6.8       | 4.80     |
| 390            | 15.7    | 6.3       | 4.25     | 985            | 23.5    | 6.6       | 4.52     | 1580           | 27.0    | 7.1       | 5.17     | 2175           | 29.8    | 7.2       | 5.20     | 2770           | 32.3    | 6.8       | 4.73     |

**Antenna factor**  
**Double-ridged waveguide horn antenna**  
**ETS Lindgren, Model 3117, serial number: 00123515, HL 4114**

| Frequency, MHz | Antenna factor, dB/m |              |           |
|----------------|----------------------|--------------|-----------|
|                | Measured             | Manufacturer | Deviation |
| 1000           | 28.0                 | 28.4         | -0.4      |
| 1500           | 28.0                 | 27.4         | 0.6       |
| 2000           | 31.2                 | 30.9         | 0.3       |
| 2500           | 32.5                 | 33.4         | -0.9      |
| 3000           | 32.9                 | 32.6         | 0.3       |
| 3500           | 32.7                 | 32.8         | -0.1      |
| 4000           | 33.1                 | 33.4         | -0.3      |
| 4500           | 33.8                 | 33.9         | -0.1      |
| 5000           | 33.8                 | 34.1         | -0.3      |
| 5500           | 34.4                 | 34.5         | -0.1      |
| 6000           | 35.0                 | 35.2         | -0.2      |
| 6500           | 35.4                 | 35.5         | -0.1      |
| 7000           | 35.7                 | 35.7         | 0.0       |
| 7500           | 35.9                 | 35.7         | 0.2       |
| 8000           | 35.8                 | 35.8         | 0.0       |
| 8500           | 35.9                 | 35.8         | 0.1       |
| 9000           | 36.3                 | 36.2         | 0.1       |
| 9500           | 36.6                 | 36.6         | 0.0       |
| 10000          | 37.1                 | 37.1         | 0.0       |
| 10500          | 37.6                 | 37.5         | 0.1       |
| 11000          | 37.9                 | 37.7         | 0.2       |
| 11500          | 38.5                 | 38.1         | 0.4       |
| 12000          | 39.2                 | 38.7         | 0.5       |
| 12500          | 39.0                 | 38.9         | 0.1       |
| 13000          | 39.1                 | 39.1         | 0.0       |
| 13500          | 38.9                 | 38.8         | 0.1       |
| 14000          | 39.0                 | 38.8         | 0.2       |
| 14500          | 39.6                 | 39.9         | -0.3      |
| 15000          | 39.9                 | 39.7         | 0.2       |
| 15500          | 39.9                 | 40.1         | -0.2      |
| 16000          | 40.7                 | 40.8         | -0.1      |
| 16500          | 41.3                 | 41.8         | -0.5      |
| 17000          | 42.5                 | 42.1         | 0.4       |
| 17500          | 41.3                 | 41.2         | 0.1       |
| 18000          | 41.4                 | 40.9         | 0.5       |

Antenna factor is to be added to receiver meter reading in dB( $\mu$ V) to convert to field strength in dB( $\mu$ V/meter)



HERMON LABORATORIES

Antenna factor, HL 4933

**Active Horn Antenna Factor Calibration**

1 GHz to 18 GHz

| <b>Equipment:</b>                                                         |                              |                                          | <b>ACTIVE HORN ANTENNA</b> |                              |                                          |
|---------------------------------------------------------------------------|------------------------------|------------------------------------------|----------------------------|------------------------------|------------------------------------------|
| <b>Model:</b>                                                             |                              |                                          | <b>AHA-118</b>             |                              |                                          |
| <b>Serial Number:</b>                                                     |                              |                                          | <b>701046</b>              |                              |                                          |
| <b>Calibration Distance:</b>                                              |                              |                                          | <b>3 Meter</b>             |                              |                                          |
| <b>Polarization:</b>                                                      |                              |                                          | <b>Horizontal</b>          |                              |                                          |
| <b>Calibration Date:</b>                                                  |                              |                                          | <b>11/12/2014</b>          |                              |                                          |
| Frequency<br>(GHz)                                                        | Preamplifier<br>Gain<br>(dB) | Antenna Factor<br>with pre-amp<br>(dB/m) | Frequency<br>(GHz)         | Preamplifier<br>Gain<br>(dB) | Antenna Factor<br>with pre-amp<br>(dB/m) |
| 1                                                                         | 40.96                        | -16.47                                   | 10                         | 40.94                        | -1.97                                    |
| 1.5                                                                       | 41.21                        | -14.53                                   | 10.5                       | 40.63                        | -1.06                                    |
| 2                                                                         | 41.44                        | -13.30                                   | 11                         | 40.74                        | -1.50                                    |
| 2.5                                                                       | 41.71                        | -12.87                                   | 11.5                       | 40.65                        | -0.52                                    |
| 3                                                                         | 41.96                        | -12.26                                   | 12                         | 40.76                        | -0.15                                    |
| 3.5                                                                       | 42.14                        | -11.77                                   | 12.5                       | 41.03                        | -0.85                                    |
| 4                                                                         | 42.13                        | -10.91                                   | 13                         | 41.37                        | -0.81                                    |
| 4.5                                                                       | 41.79                        | -9.41                                    | 13.5                       | 41.18                        | 0.05                                     |
| 5                                                                         | 41.44                        | -7.54                                    | 14                         | 40.98                        | 0.36                                     |
| 5.5                                                                       | 40.91                        | -6.47                                    | 14.5                       | 40.81                        | 1.26                                     |
| 6                                                                         | 40.69                        | -5.48                                    | 15                         | 40.65                        | 0.25                                     |
| 6.5                                                                       | 40.64                        | -5.53                                    | 15.5                       | 40.93                        | -1.05                                    |
| 7                                                                         | 40.76                        | -4.12                                    | 16                         | 41.31                        | -1.44                                    |
| 7.5                                                                       | 40.94                        | -3.12                                    | 16.5                       | 40.96                        | -0.80                                    |
| 8                                                                         | 40.68                        | -1.69                                    | 17                         | 40.64                        | -0.02                                    |
| 8.5                                                                       | 40.08                        | -1.71                                    | 17.5                       | 40.57                        | 1.81                                     |
| 9                                                                         | 40.41                        | -1.86                                    | 18                         | 40.08                        | 3.63                                     |
| 9.5                                                                       | 41.21                        | -2.73                                    |                            |                              |                                          |
| Calibration according to ARP 958                                          |                              |                                          |                            |                              |                                          |
| <b>Antenna Factor to be added to receiver reading:</b>                    |                              |                                          |                            |                              |                                          |
| Meter Reading (dBuV) + Antenna Factor (dB/m) = Corrected Reading (dBuV/m) |                              |                                          |                            |                              |                                          |



HERMON LABORATORIES

Antenna factor, HL 4956

**Active Horn Antenna Factor Calibration**

18 GHz to 40 GHz

| <b>Equipment:</b>                                                                                                                                                          |                              |                                          | <b>ACTIVE HORN ANTENNA</b> |                              |                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------------------------------------------|----------------------------|------------------------------|------------------------------------------|
| <b>Model:</b>                                                                                                                                                              |                              |                                          | <b>AHA-840</b>             |                              |                                          |
| <b>Serial Number:</b>                                                                                                                                                      |                              |                                          | <b>105004</b>              |                              |                                          |
| <b>Calibration Distance:</b>                                                                                                                                               |                              |                                          | <b>3 meter</b>             |                              |                                          |
| <b>Polarization:</b>                                                                                                                                                       |                              |                                          | <b>Horizontal</b>          |                              |                                          |
| <b>Calibration Date:</b>                                                                                                                                                   |                              |                                          | <b>1/26/2015</b>           |                              |                                          |
| Frequency<br>(GHz)                                                                                                                                                         | Preamplifier<br>Gain<br>(dB) | Antenna Factor<br>with pre-amp<br>(dB/m) | Frequency<br>(GHz)         | Preamplifier<br>Gain<br>(dB) | Antenna Factor<br>with pre-amp<br>(dB/m) |
| 18                                                                                                                                                                         | 38.83                        | -1.06                                    | 29.5                       | 42.47                        | -5.33                                    |
| 18.5                                                                                                                                                                       | 39.34                        | -2.65                                    | 30                         | 41.91                        | -4.86                                    |
| 19                                                                                                                                                                         | 39.71                        | -3.88                                    | 30.5                       | 41.60                        | -4.64                                    |
| 19.5                                                                                                                                                                       | 39.87                        | -4.35                                    | 31                         | 41.52                        | -4.60                                    |
| 20                                                                                                                                                                         | 39.98                        | -3.97                                    | 31.5                       | 41.56                        | -4.79                                    |
| 20.5                                                                                                                                                                       | 40.42                        | -3.68                                    | 32                         | 41.80                        | -5.21                                    |
| 21                                                                                                                                                                         | 41.12                        | -4.06                                    | 32.5                       | 42.29                        | -5.54                                    |
| 21.5                                                                                                                                                                       | 41.74                        | -5.46                                    | 33                         | 42.79                        | -5.63                                    |
| 22                                                                                                                                                                         | 42.14                        | -6.22                                    | 33.5                       | 42.88                        | -5.38                                    |
| 22.5                                                                                                                                                                       | 42.35                        | -6.42                                    | 34                         | 42.62                        | -4.76                                    |
| 23                                                                                                                                                                         | 42.50                        | -6.59                                    | 34.5                       | 42.63                        | -4.84                                    |
| 23.5                                                                                                                                                                       | 42.65                        | -6.82                                    | 35                         | 43.15                        | -5.13                                    |
| 24                                                                                                                                                                         | 42.81                        | -7.01                                    | 35.5                       | 43.91                        | -5.83                                    |
| 24.5                                                                                                                                                                       | 42.86                        | -7.37                                    | 36                         | 44.59                        | -6.39                                    |
| 25                                                                                                                                                                         | 42.73                        | -7.53                                    | 36.5                       | 45.04                        | -6.64                                    |
| 25.5                                                                                                                                                                       | 42.77                        | -7.45                                    | 37                         | 45.08                        | -6.40                                    |
| 26                                                                                                                                                                         | 42.85                        | -7.21                                    | 37.5                       | 44.82                        | -5.75                                    |
| 26.5                                                                                                                                                                       | 42.98                        | -7.17                                    | 38                         | 44.16                        | -4.58                                    |
| 27                                                                                                                                                                         | 43.14                        | -7.22                                    | 38.5                       | 42.90                        | -2.66                                    |
| 27.5                                                                                                                                                                       | 43.18                        | -7.32                                    | 39                         | 42.39                        | -1.71                                    |
| 28                                                                                                                                                                         | 43.04                        | -7.10                                    | 39.5                       | 43.76                        | -2.49                                    |
| 28.5                                                                                                                                                                       | 43.01                        | -6.73                                    | 40                         | 45.98                        | -5.21                                    |
| <p>Calibration per ANSI C63.5: 2006</p> <p><b>Standard Site Method, Equations 1-6 (3-antenna)</b></p> <p>Corrected Reading (dBμV/m) = Meter Reading (dBμV) + AFE(dB/m)</p> |                              |                                          |                            |                              |                                          |



**Cable loss**  
**RF Cable, Huber-Suhner, 18 GHz, 6 m, N- type,**  
**SF106A/11N/11N/6000MM, S/N 500849/6A**  
**HL 5103**

| Frequency,<br>MHz | Cable loss,<br>dB | Frequency,<br>MHz | Cable loss,<br>dB |
|-------------------|-------------------|-------------------|-------------------|
| 0.1               | 0.01              | 5500              | 2.43              |
| 50                | 0.22              | 6000              | 2.54              |
| 100               | 0.31              | 6500              | 2.66              |
| 200               | 0.43              | 7000              | 2.76              |
| 300               | 0.53              | 7500              | 2.87              |
| 400               | 0.62              | 8000              | 2.97              |
| 500               | 0.69              | 8500              | 3.07              |
| 600               | 0.76              | 9000              | 3.17              |
| 700               | 0.82              | 9500              | 3.27              |
| 800               | 0.88              | 10000             | 3.36              |
| 900               | 0.94              | 10500             | 3.45              |
| 1000              | 0.99              | 11000             | 3.54              |
| 1100              | 1.04              | 11500             | 3.62              |
| 1200              | 1.08              | 12000             | 3.71              |
| 1300              | 1.13              | 12500             | 3.79              |
| 1400              | 1.17              | 13000             | 3.88              |
| 1500              | 1.21              | 13500             | 3.97              |
| 1600              | 1.26              | 14000             | 4.05              |
| 1700              | 1.30              | 14500             | 4.13              |
| 1800              | 1.33              | 15000             | 4.22              |
| 1900              | 1.37              | 15500             | 4.30              |
| 2000              | 1.41              | 16000             | 4.38              |
| 2500              | 1.59              | 16500             | 4.45              |
| 3000              | 1.75              | 17000             | 4.52              |
| 3500              | 1.90              | 17500             | 4.61              |
| 4000              | 2.04              | 18000             | 4.72              |
| 4500              | 2.17              |                   |                   |
| 5000              | 2.30              |                   |                   |

**Cable loss**  
**RF Cable, Huber-Suhner, 18 GHz, 6 m, N- type,**  
**SF106A/11N/11N/4500MM, S/N 500845/6A**  
**HL 5107**

| Frequency,<br>MHz | Cable loss,<br>dB | Frequency,<br>MHz | Cable loss,<br>dB |
|-------------------|-------------------|-------------------|-------------------|
| 0.1               | 0.01              | 5500              | 1.75              |
| 50                | 0.16              | 6000              | 1.84              |
| 100               | 0.22              | 6500              | 1.92              |
| 200               | 0.31              | 7000              | 2.00              |
| 300               | 0.38              | 7500              | 2.07              |
| 400               | 0.44              | 8000              | 2.15              |
| 500               | 0.49              | 8500              | 2.23              |
| 600               | 0.54              | 9000              | 2.29              |
| 700               | 0.58              | 9500              | 2.38              |
| 800               | 0.63              | 10000             | 2.43              |
| 900               | 0.67              | 10500             | 2.50              |
| 1000              | 0.71              | 11000             | 2.57              |
| 1100              | 0.74              | 11500             | 2.63              |
| 1200              | 0.77              | 12000             | 2.69              |
| 1300              | 0.81              | 12500             | 2.76              |
| 1400              | 0.84              | 13000             | 2.82              |
| 1500              | 0.87              | 13500             | 2.87              |
| 1600              | 0.91              | 14000             | 2.93              |
| 1700              | 0.93              | 14500             | 3.00              |
| 1800              | 0.96              | 15000             | 3.06              |
| 1900              | 0.99              | 15500             | 3.12              |
| 2000              | 1.01              | 16000             | 3.18              |
| 2500              | 1.14              | 16500             | 3.22              |
| 3000              | 1.26              | 17000             | 3.28              |
| 3500              | 1.37              | 17500             | 3.36              |
| 4000              | 1.47              | 18000             | 3.43              |
| 4500              | 1.57              |                   |                   |
| 5000              | 1.66              |                   |                   |

**Cable loss**  
**RF Cable, Huber-Suhner, 18 GHz, 3 m, N- type,**  
**ST18A/Nm/Nm/3000, S/N 600818/18A**  
**HL 5110**

| Frequency,<br>MHz | Cable loss,<br>dB | Frequency,<br>MHz | Cable loss,<br>dB |
|-------------------|-------------------|-------------------|-------------------|
| 0.1               | 0.01              | 5500              | 1.99              |
| 50                | 0.17              | 6000              | 2.10              |
| 100               | 0.24              | 6500              | 2.20              |
| 200               | 0.34              | 7000              | 2.29              |
| 300               | 0.42              | 7500              | 2.38              |
| 400               | 0.48              | 8000              | 2.47              |
| 500               | 0.54              | 8500              | 2.57              |
| 600               | 0.59              | 9000              | 2.65              |
| 700               | 0.64              | 9500              | 2.74              |
| 800               | 0.69              | 10000             | 2.83              |
| 900               | 0.73              | 10500             | 2.91              |
| 1000              | 0.77              | 11000             | 2.99              |
| 1100              | 0.82              | 11500             | 3.07              |
| 1200              | 0.86              | 12000             | 3.14              |
| 1300              | 0.89              | 12500             | 3.22              |
| 1400              | 0.93              | 13000             | 3.29              |
| 1500              | 0.96              | 13500             | 3.37              |
| 1600              | 1.00              | 14000             | 3.45              |
| 1700              | 1.03              | 14500             | 3.52              |
| 1800              | 1.06              | 15000             | 3.59              |
| 1900              | 1.10              | 15500             | 3.66              |
| 2000              | 1.13              | 16000             | 3.74              |
| 2500              | 1.28              | 16500             | 3.80              |
| 3000              | 1.41              | 17000             | 3.88              |
| 3500              | 1.54              | 17500             | 4.00              |
| 4000              | 1.66              | 18000             | 4.02              |
| 4500              | 1.78              |                   |                   |
| 5000              | 1.89              |                   |                   |

**Cable loss**  
**RF Cable, Huber-Suhner, 40 GHz, 5.5 m, K type,**  
**SF102EA/11SK/11SK/5500MM, S/N 502494/2EA**  
**HL 5112**

| Frequency,<br>MHz | Cable loss,<br>dB | Frequency,<br>MHz | Cable loss,<br>dB |
|-------------------|-------------------|-------------------|-------------------|
| 100               | 0.69              | 20500             | 10.18             |
| 200               | 0.97              | 21000             | 10.32             |
| 300               | 1.18              | 21500             | 10.47             |
| 500               | 1.52              | 22000             | 10.60             |
| 1000              | 2.14              | 22500             | 10.75             |
| 1500              | 2.62              | 23000             | 10.87             |
| 2000              | 3.03              | 23500             | 11.00             |
| 2500              | 3.40              | 24000             | 11.12             |
| 3000              | 3.73              | 24500             | 11.23             |
| 3500              | 4.04              | 25000             | 11.35             |
| 4000              | 4.33              | 25500             | 11.52             |
| 4500              | 4.60              | 26000             | 11.64             |
| 5000              | 4.86              | 26500             | 11.73             |
| 5500              | 5.10              | 27000             | 11.84             |
| 6000              | 5.34              | 27500             | 11.93             |
| 6500              | 5.57              | 28000             | 12.05             |
| 7000              | 5.79              | 28500             | 12.19             |
| 7500              | 6.00              | 29000             | 12.33             |
| 8000              | 6.21              | 29500             | 12.44             |
| 8500              | 6.43              | 30000             | 12.53             |
| 9000              | 6.62              | 30500             | 12.58             |
| 9500              | 6.82              | 31000             | 12.71             |
| 10000             | 7.01              | 31500             | 12.86             |
| 10500             | 7.17              | 32000             | 13.00             |
| 11000             | 7.34              | 32500             | 13.11             |
| 11500             | 7.51              | 33000             | 13.24             |
| 12000             | 7.68              | 33500             | 13.33             |
| 12500             | 7.84              | 34000             | 13.44             |
| 13000             | 8.00              | 34500             | 13.58             |
| 13500             | 8.16              | 35000             | 13.69             |
| 14000             | 8.32              | 35500             | 13.81             |
| 14500             | 8.48              | 36000             | 13.93             |
| 15000             | 8.63              | 36500             | 14.05             |
| 15500             | 8.77              | 37000             | 14.24             |
| 16000             | 8.92              | 37500             | 14.28             |
| 16500             | 9.08              | 38000             | 14.38             |
| 17000             | 9.23              | 38500             | 14.50             |
| 17500             | 9.37              | 39000             | 14.61             |
| 18000             | 9.51              | 39500             | 14.70             |
| 18500             | 9.66              | 40000             | 14.83             |
| 19000             | 9.78              |                   |                   |
| 19500             | 9.92              |                   |                   |
| 20000             | 10.07             |                   |                   |

## 14 APPENDIX F Abbreviations and acronyms

|                |                                             |
|----------------|---------------------------------------------|
| A              | ampere                                      |
| AC             | alternating current                         |
| AM             | amplitude modulation                        |
| AVRG           | average (detector)                          |
| cm             | centimeter                                  |
| dB             | decibel                                     |
| dBm            | decibel referred to one milliwatt           |
| dB( $\mu$ V)   | decibel referred to one microvolt           |
| dB( $\mu$ V/m) | decibel referred to one microvolt per meter |
| dB( $\mu$ A)   | decibel referred to one microampere         |
| DC             | direct current                              |
| EIRP           | equivalent isotropically radiated power     |
| ERP            | effective radiated power                    |
| EUT            | equipment under test                        |
| F              | frequency                                   |
| GHz            | gigahertz                                   |
| GND            | ground                                      |
| H              | height                                      |
| HL             | Hermon laboratories                         |
| Hz             | hertz                                       |
| k              | kilo                                        |
| kHz            | kilohertz                                   |
| LO             | local oscillator                            |
| m              | meter                                       |
| MHz            | megahertz                                   |
| min            | minute                                      |
| mm             | millimeter                                  |
| ms             | millisecond                                 |
| $\mu$ s        | microsecond                                 |
| NA             | not applicable                              |
| NB             | narrow band                                 |
| OATS           | open area test site                         |
| $\Omega$       | Ohm                                         |
| PM             | pulse modulation                            |
| PS             | power supply                                |
| ppm            | part per million ( $10^{-6}$ )              |
| QP             | quasi-peak                                  |
| RE             | radiated emission                           |
| RF             | radio frequency                             |
| rms            | root mean square                            |
| Rx             | receive                                     |
| s              | second                                      |
| T              | temperature                                 |
| Tx             | transmit                                    |
| V              | volt                                        |
| WB             | wideband                                    |

END OF DOCUMENT